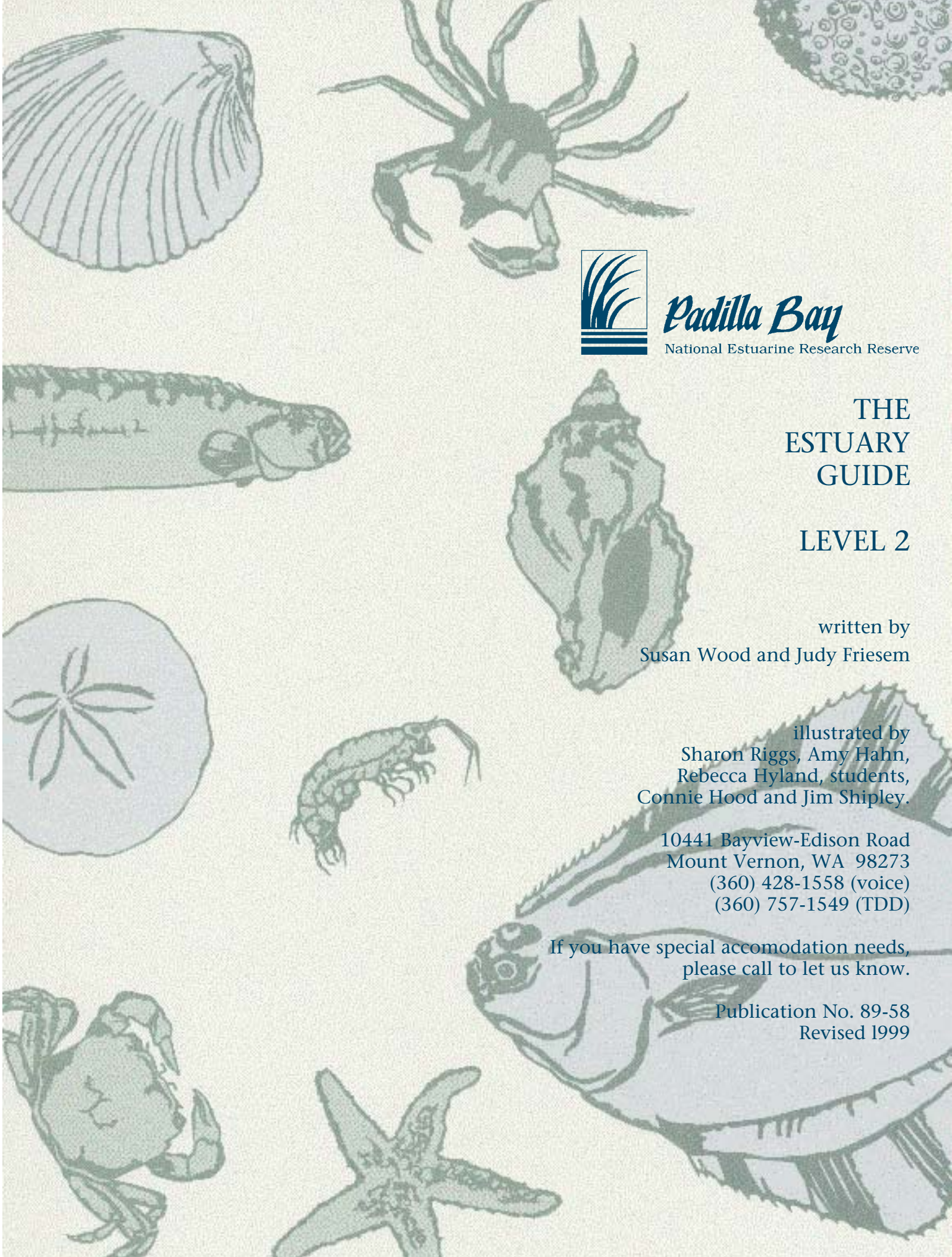

Padilla Bay
National Estuarine Research Reserve

THE ESTUARY GUIDE

LEVEL 2

written by
Susan Wood and Judy Friesem

illustrated by
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Rebecca Hyland, students,
Connie Hood and Jim Shipley.

10441 Bayview-Edison Road
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If you have special accomodation needs,
please call to let us know.

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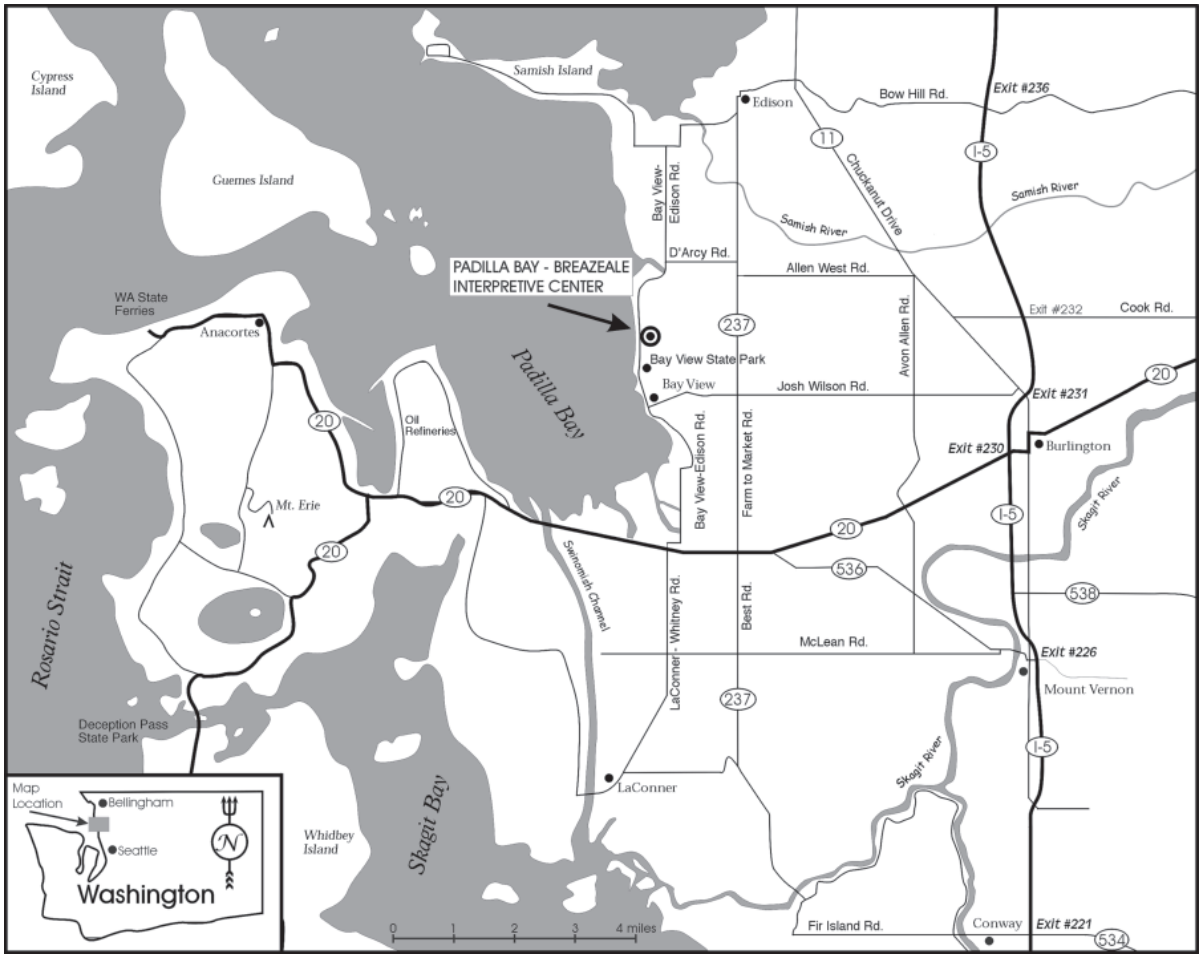

Cypress Island
Samish Island
Guemes Island
Edison
Bow Hill Rd.
Exit #236
I-5
11
Chuckanut Drive
Samish River
Bay View-Edison Rd.
D'Arcy Rd.
PADILLA BAY - BREAZEALE INTERPRETIVE CENTER
Allen West Rd.
Exit #232
Cook Rd.
WA State Ferries
Anacortes
237
Bay View State Park
Bay View
Josh Wilson Rd.
Avon Allen Rd.
Exit #231
20
Padilla Bay
Oil Refineries
Exit #230
Burlington
Mt. Erie
Bay View-Edison Rd.
Farm to Market Rd.
Skagit River
Rosario Strait
Swinomish Channel
536
538
Best Rd.
LaConner - Whitney Rd.
McLean Rd.
Exit #226
Mount Vernon
Deception Pass State Park
LaConner
Skagit River
Map Location
Bellingham
Seattle
Washington
Whidbey Island
Skagit Bay
0 1 2 3 4 miles
Fir Island Rd.
Conway
Exit #221
534

Table of Contents

Table of Contents

Introduction

This guide is designed for teachers of fourth through eighth grades to compliment a visit to the Padilla Bay National Estuarine Research Reserve. It is also a useful resource to anyone teaching about watersheds, estuaries, shorelands, and coastal resources.

It is divided into four sections:

- PRE-TRIP information and activities
- ON-SITE materials
- POST-TRIP ideas
- RESOURCES

A variety of activities is included, designed to weave together many subjects and many ways of learning. Our hope is that some will fit comfortably into your class work and with your unique style of teaching.

There is a wealth of beauty, humor and truths stranger-than-fiction out there waiting to be understood. May these beginning activities lead to a closer bonding between people and the natural world.

Padilla Bay has been designated as a National Estuarine Research Reserve, managed by the Washington State Department of Ecology in cooperation with the National Oceanic and Atmospheric Administration (NOAA). One of 25 reserves around the country, Padilla Bay is set up as a natural field laboratory for research and education, with the goal of enhancing public awareness of the value of estuaries and improving coastal resource management.

Teacher Checklist

Pre trip:

___ Read through this curriculum packet.

___ Arrange for adequate adult supervision. (We suggest one adult for every 5 to 8 children.)

___ Prepare adults by giving them the Parent Page on page 27. Be sure drivers have the map on page iv.

___ Make legible name tags for all.

___ Emphasize the importance of warm outdoor clothing: warm jackets, rain gear, hats, and gloves during October - May. Snug boots or old shoes that tie are best for low tide dates.

___ Consider using one or more of the pre-trip activities on pages 9 to 23. Prepared students benefit most from our program.

___ If you will be visiting the beach at Bayview State Park on your own, please read through "On Your Own At the Beach" on page 30.

On Site:

___ Are your students wearing name tags?

___ Please arrive at your scheduled time or call to let us know of a change.

___ Enjoy!

Post trip:

___ Continue the estuary studies back in your classroom with some of the many activities listed on pages 37-83 of this curriculum.

___ If you have suggestions for any improvements or changes we could make to our program, please write or call (360)428-1558.

___ Our programs are supported by State and Federal funds as well as a non-profit foundation. We encourage groups to join or make a donation to:

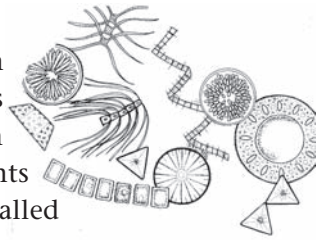
The Padilla Bay Foundation
PO Box 1305
Mount Vernon, WA 98273

A Bit About Estuaries ...

The Skagit River begins in the North Cascades. It tumbles down mountainsides, spills over waterfalls, runs past towns and under bridges, winds through the fertile Skagit Valley and eventually slows down as it nears its estuary, the Skagit Delta. An estuary: the place where a river meets the sea.

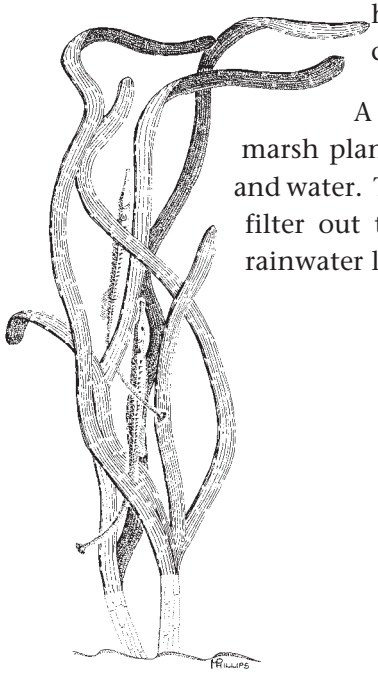
Estuaries are remarkable places, rich with treasures hidden to the casual observer. Life is concentrated here. The amount of plant material produced in an estuary far exceeds that of even our best-tended wheat fields. In turn, plants provide food and shelter for a myriad of animals. The bay is a veritable garden.

Plants



The complex marine food web begins with phytoplankton, the tiny, free-floating plants that thrive in the shallow, sunlit, nutrient-rich water. Phytoplankton belong to a group of plants called algae. Larger algae are commonly called seaweeds.

Another producer is eelgrass, a flowering marine plant which carpets Padilla Bay. It offers food and shelter to the many animals that live on and among its blades. Eelgrass is valuable both as habitat while it is living, and as a food once it has died and decayed.

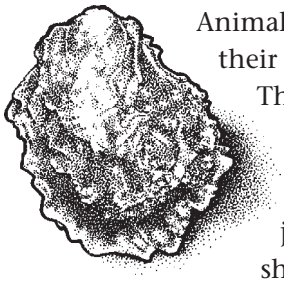


A third major group of plants consists of the salt marsh plants that form the transition zone between land and water. These specialized plants add nutrients to the bay, filter out toxins from land run-off, and soak up excess rainwater like a sponge.

A Bit About Estuaries ...

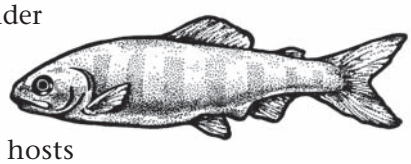
Animals

The abundant plant life in an estuary attracts incredible numbers of animals, for it provides ample food and shelter. Estuaries can be a home, a nursery or a rest stop for migrating animals.



Animals such as oysters, clams, worms, crabs, and snails begin their life as zooplankton and settle down as they mature. These invertebrates provide food for larger animals such as birds and fish.

Salmon need to spend time in an estuary on their journey to the sea. The bay provides food, protective shelter, and a gentle transition stage from the fresh water to the salt. Juvenile Dungeness crab, herring, and flounder are some of the many animals found in large numbers in the shallow waters of the estuary.



Padilla Bay is located along a major flyway and hosts thousands of migrating birds, including shorebirds, ducks, brant geese, and raptors such as eagles and falcons. Some choose to winter here, while others continue southward.

"Estuary" comes from the Latin word "aestus," meaning "tides." Twice a day the tides fill and empty the bay. Seasonal cycles and daily fluctuations of tides, salinity and temperature create a unique environment that can be incredibly stressful to its inhabitants. Species that have adapted to the stresses tend to be numerous, attesting to the high productivity and natural wealth in an estuary.

A Bit About Estuaries ...

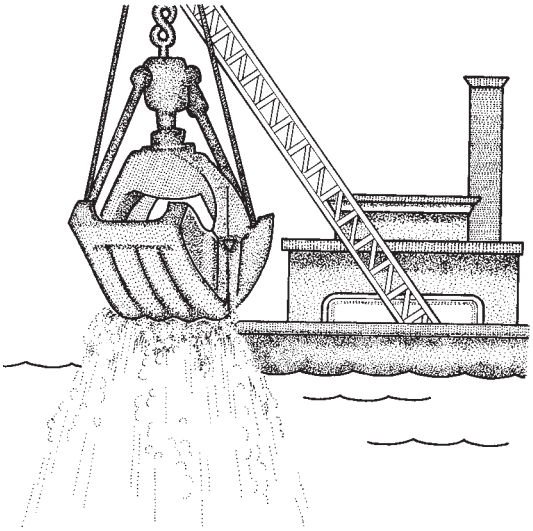
People

People are much like birds. We, too, "flock" to estuaries for the natural resources, edible as well as aesthetic, and for the ease of transportation by land, water and air. The scenic backdrop for recreational activities and the peace and beauty at the water's edge lure us. More than half of the U.S. population resides near an estuary. Most of the people in Washington state live on the coast, near an estuary (Puget Sound) - - and these numbers are steadily increasing.

Growing "appreciation" is a mixed blessing. Estuaries have been used and much abused in the past. Seen as barren and muddy wastelands, they have been targeted sites for dredging, diking, and dumping of wastes. Development is often accompanied by habitat loss, polluted runoff, increased erosion, and other water quality problems.

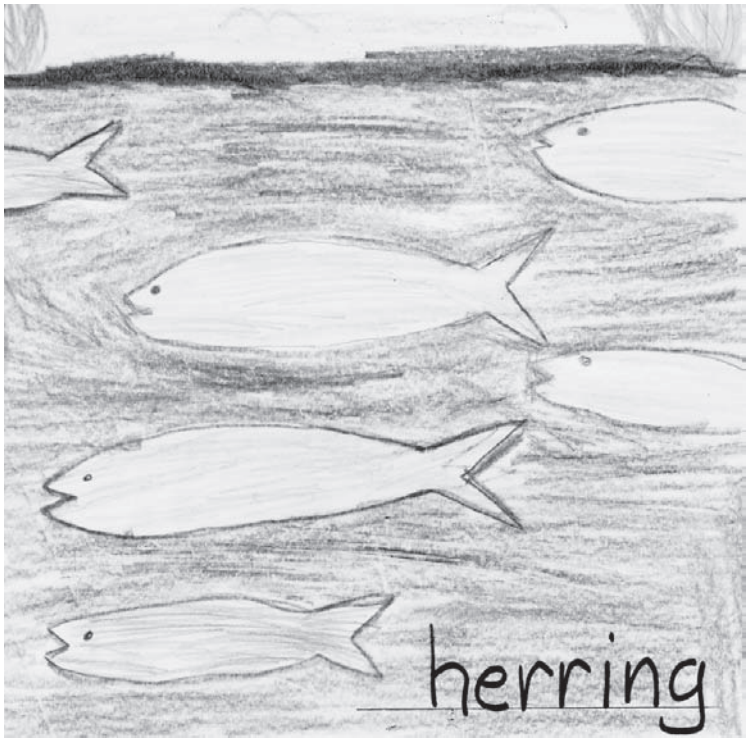
There are many things individuals can do to change this trend. Learning more about estuaries is a good first step, followed by a close examination of our own decisions and behaviors that affect estuaries.

We are glad you are here to learn with us.



Pre Trip

Pre trip Activities



by Tessa

Introducing Your Class to Estuaries

Help your students get the most out of their field trip.

The activities in this section are designed to give students a common vocabulary and background on estuaries.

Begin with a discussion. Be sure your students know a simple definition of "estuary." Look at a map of the United States and notice different shapes and sizes of estuaries. Share "water experiences," comparing ocean, estuary, and fresh water beaches. Make a list of the questions that come up, and bring it to Padilla Bay. See how many questions can be answered after your trip.

Try some of the activities in this Pre-trip section. We especially recommend the Watershed Search on page 14 and the story writing activity on page 20.

Read *Pagoo* by Holling Clancy Holling. Detailed and accurate information about tidepool creatures is presented in a colorful, enjoyable story. (See Resources section for publisher information and other recommended books.)

A Bit About Estuaries...

In the Pacific Northwest, rivers begin in the mountains. Water from rain, snow, and melting glaciers gathers in streams. It tumbles down mountainsides, spills over waterfalls, runs past towns and under bridges, and winds through rich farmland. The river finally slows down as it nears the sea. An estuary is the place where fresh water from the land meets the salt water of the sea.

Estuaries are amazing places. They are home to all sorts of plants and animals that are specially adapted to live in a changing environment. Because of the tides, an estuary plant or animal may have to face hot, dry sun and cold salty ocean water. Waves can stir up thick mud, and torrents of fresh water after a hard rain can make the water "too fresh" for many animals. It's not easy to live in a place that changes so much, but for those that do survive, the estuary offers something else: food.

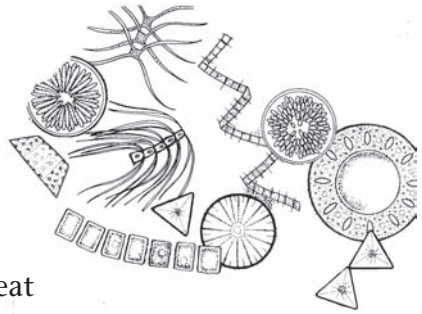
Questions:

l. What is an estuary?

2. Why is it hard for animals to live in an estuary?

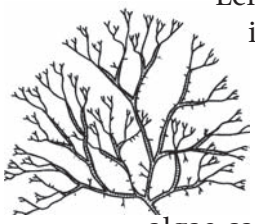
Plants

An estuary food web begins with the producers. Plants use sunlight energy for photosynthesis, combining carbon dioxide (CO_2) and water (H_2O) to make sugar and oxygen. The sunlight energy is stored in the plants which can be eaten and used by animals. Without photosynthesis, animals (including people) would have nothing to eat and nothing to breathe!



A Bit About Estuaries...

Phytoplankton are the tiny, free-floating plants. Though they are microscopic, there are billions of them, and they are very important. Many small animals eat phytoplankton and it gives off much of our planet's oxygen.



Eelgrass grows tall and thin and can be 8 or 10 feet tall. This is a flowering plant much like the grass in a field. It covers Padilla Bay like a green forest and is home to many animals that live on its blades.

A third type of plant is algae. Algae are sometimes called seaweed, and come in many shapes and sizes. Green algae can look like a flat leaf of lettuce or thin strands of hair. Brown kelp can grow to be 60 feet tall, with long, shiny blades that float in the currents. Some red algae has finely branched blades that look like lace.

Together, all these plants turn sunlight energy into food for animals living in the estuary.

Questions:

1. Name 3 kinds of estuary plants.

2. Where do plants get their energy?

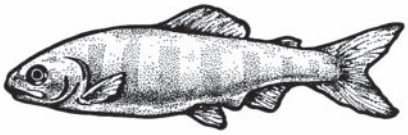
3. What gets energy from the plants?

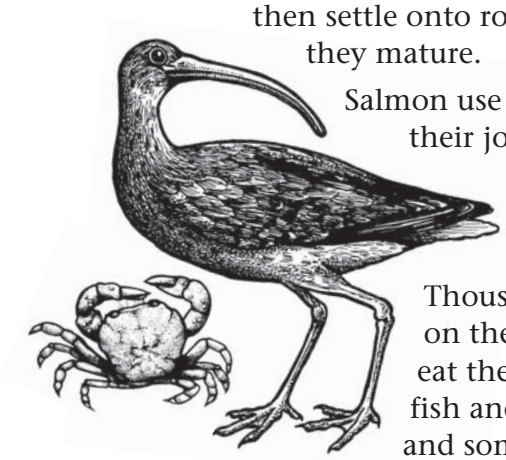
A Bit About Estuaries...

Animals

An estuary provides important habitat for many animals. It can be a home, a rest stop or a nursery.

It is used as a home by animals like oysters, clams, worms, and snails that spend their whole lives in estuaries. They begin as free-floating zooplankton (tiny animals) and then settle onto rocks or into the mud as they mature.





Salmon use estuaries as a rest stop on their journey from the river to the sea. The estuary provides food, shelter, and a place for the young salmon to adjust to the salty ocean water.

Thousands of migrating birds also stop at estuaries on their long trip between north and south. Some eat the eelgrass and algae, while others dive for small fish and shellfish. Some stay and spend the winter, and some just rest for a time and move on.

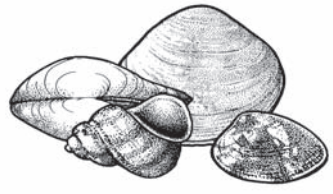
Many animals use the estuary as a nursery. Baby Dungeness crabs can hide from predators in the eelgrass meadows until they are old enough to move to deeper water. Harbor seal pups can grow up safely in the protected bay. Most marine animals are somehow connected to an estuary.

Questions:

1. Name 3 ways animals use estuaries.

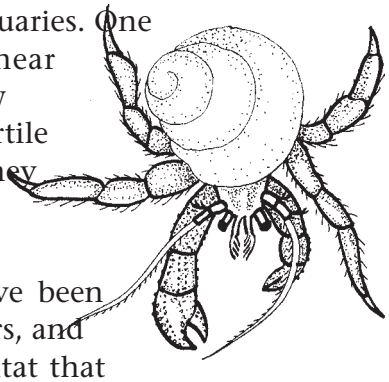
2. Name an animal that uses an estuary as a nursery.

3. Why do you think there are so many animals in an estuary?



A Bit About Estuaries...

People



For thousands of years, people have lived near estuaries. One reason Northwest Native Americans settled near estuaries was the plentiful food. In the 1800s, new settlers from the east coast arrived. They found fertile soil for farming, and like the Native Americans, they hunted and fished in the estuaries.

Today, people still use estuaries. Most of our largest cities are built on estuaries. Marshes have been drained, mud flats have been deepened for harbors, and shorelines have been changed. Much of the habitat that animals like salmon and crabs depend on is now gone.

You are connected to an estuary, too. A watershed is all the land that drains into a body of water. Your watershed eventually drains into an estuary, so what you and your family do on the land, and how you take care of your water affects your estuary. The water that rains on your yard or goes down the drain at your house probably ends up in the estuary.

If you visit a beach on Puget Sound, your actions can affect the estuary. Things like littering, leaving rocks overturned, and spilling gas from a boat can be harmful to estuary plants and animals. Whether you are right in the middle of an estuary or miles up the river, your actions make a difference.

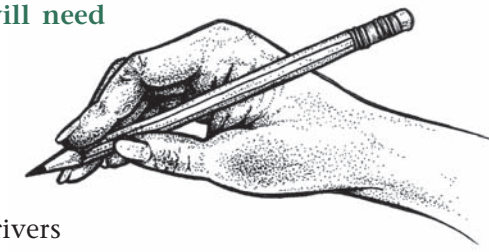
Questions:

1. Name 3 reasons people live near estuaries.

2. Think of 3 things you can do to keep estuaries healthy.

Watershed Search

Follow these directions for the accompanying map. You will need blue, green, red and regular-leaded pencils.

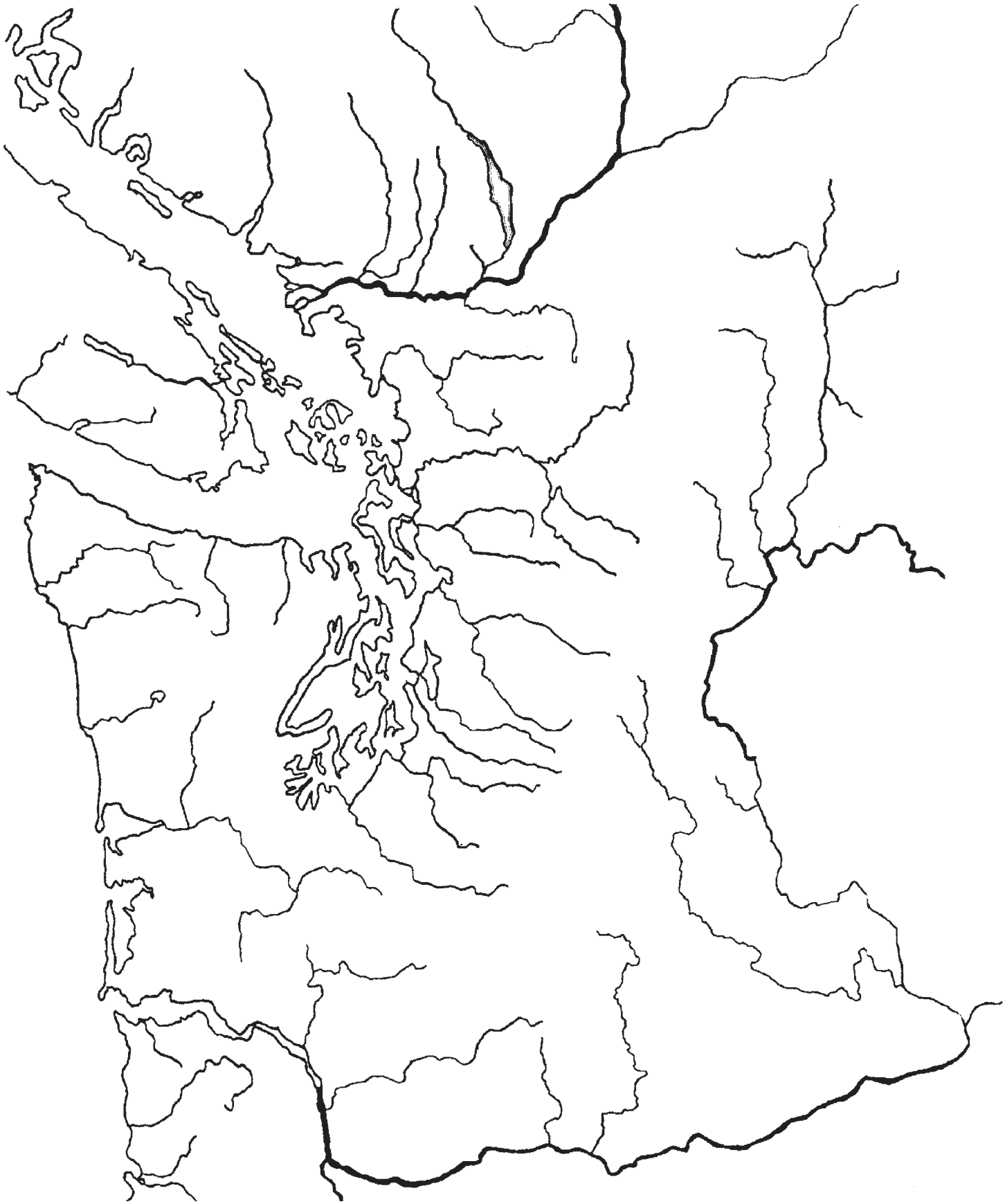


1. What is the name of your city? Locate and label it on the map and write it in with your pencil.
2. Find the river nearest to where you live. Label the mountain range where it begins.
3. In BLUE, trace the path of this river from its source to where it meets the sea.
4. With a GREEN pencil, color in the salt water near the mouth of that river.
5. In RED, circle where the freshwater river meets and mixes with the salt water from the ocean. This place is called an estuary.
6. Find and label these rivers and trace their paths using BLUE: Fraser, Nooksack, Skagit, Stillaguamish, Snohomish, Duwamish, Puyallup, Nisqually, Deschutes, Chehalis, Willapa, Columbia.
7. In RED, circle the estuaries where these rivers meet the salt water.
8. Label the following cities with your regular pencil: Portland, Olympia, Tacoma, Seattle, Everett, Stanwood, Bellingham, Vancouver, BC.
9. How many of these cities are near an estuary?
10. Find and label Puget Sound and the Strait of Georgia. This "inland sea" is one large estuary with many smaller estuaries in it. Color it blue.

As you may have noticed, many cities in Washington are built near an estuary. This is also true for many of the largest cities in the world.

Bonus: Look at a world map. List 10 large cities built on estuaries. Make a list of ways these cities might affect their estuary.

Adapted from South Slough National Estuarine Research Reserve



Vocabulary

estuary: a place where fresh water mixes with salty sea water

watershed: all the land area that drains into a body of water

habitat: the place where a plant or animal lives

food chain: the transfer of energy (food) from plants to one or more organisms.

food web: overlapping and connecting food chains

photosynthesis: when plants use sunlight to change carbon dioxide and water into food and oxygen

plankton: tiny plants and animals that float freely in water

phytoplankton: free-floating microscopic plants

zooplankton (ZOH-plankton): free-floating microscopic animals

detritus (dee-TRY-tus): decaying bits of plants and animals

producer: something that makes its own food, such as a plant

consumer: an animal that eats plants or other animals

predator: an animal which captures and feeds on other animals

prey: an animal that is hunted by another for food

decomposer: an organism that breaks down dead materials such as leaves and animals

scavenger: an animal that eats dead and decaying things

algae: a type of plant without true stems, roots, and leaves — seaweeds

diatom: a type of single-celled phytoplankton

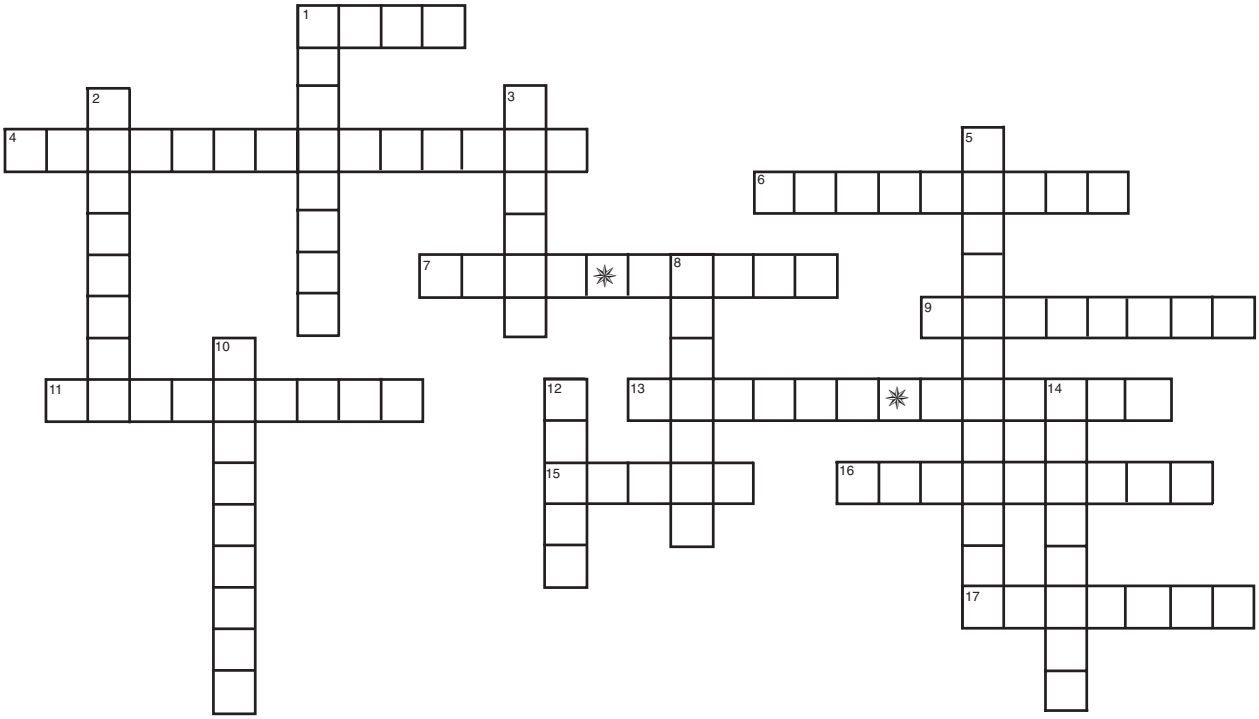
filter feeder: an animal, like a clam or oyster, that filters food from the water

invertebrate: an animal without a backbone

migration: the seasonal movement from one place to another

wrack: the tangled pile of dead plants left on the beach when the tide goes out

Crossword



Across

1. When small fish are caught and eaten by large fish they are _____
4. The process of making food with energy from the sun
6. An animal, like a crab, that eats dead stuff
7. Phytoplankton ➔ zooplankton ➔ little fish ➔ big fish ➔ eagle
9. Something that makes its own food, like a plant
11. Eagles and orcas catch animals to eat, so they are called _____
13. Barnacles, clams, and baleen whales are this kind of eater
15. Seaweeds
16. Seasonal movement from one place to another
17. A place where fresh river water mixes with salty sea water

Down

1. Tiny organisms that float freely in the water
2. This can't produce its own food, so it eats plants or other animals
3. This phytoplankton has one cell and a tiny shell
5. An animal without a backbone
8. The place where an animal or plant lives
10. What happens here can affect the water that runs into the estuary
12. The tangled mass of seaweeds and organisms washed ashore
14. Bits of dead plants and animals

Use These Words

algae
consumer
detritus
diatom
filter feeder
food chain
habitat
invertebrate
migration
photosynthesis
plankton
predators
prey
producer
estuary
scavenger
wrack
watershed

Estuary Word Search

A D L M S L I R P L A R D U P E S D
L E C O Z O O Y N O T K N A L P R I
O T E T E M I G R D N O C C A S S A
S R N A M U E O S Y S T R O R P L S
H I C J D E C O M P O S E R M A E M
O T N S D G H K E E T D S O R A S U
O U A V S C A V E N Y E T I E A C A
T S R O E E B L N I K A U T E A A N
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S O N B C S T Y I D V Q R C N I S A
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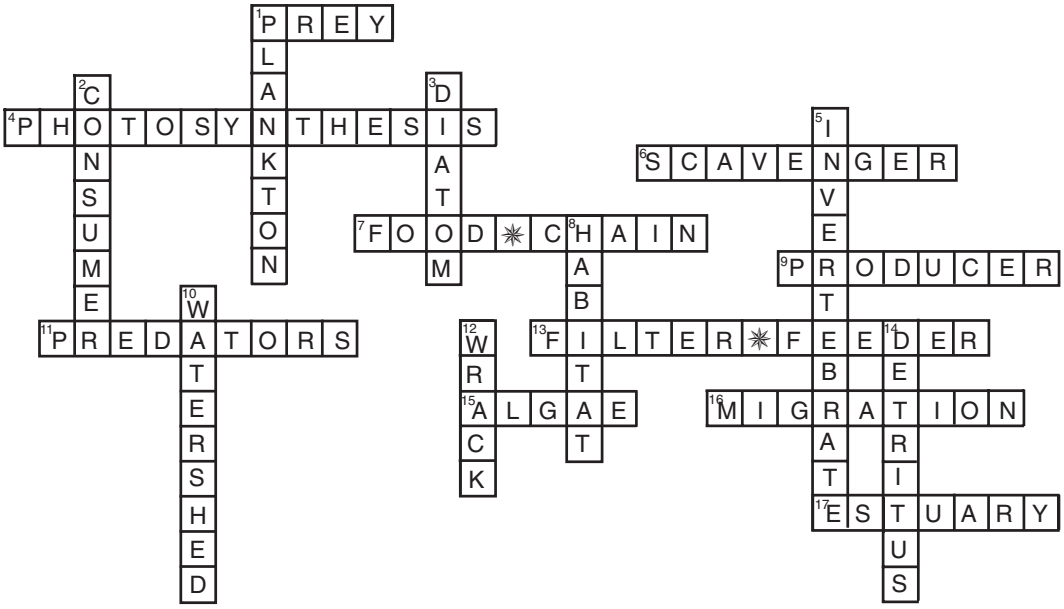
ALGAE
DECOMPOSER
DETRITUS
DIATOM
ESTUARY
FOOD CHAIN
HABITAT
INVERTEBRATE
MIGRATION
MUD
OCEAN
PHOTOSYNTHESIS
PLANKTON
PREDATOR
PREY
SCAVENGER
WATERSHED
WORM
WRACK

Puzzle Keys


1 PREY
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3 D
4 PHOTOSYNTHESIS
5 I
6 SCAVENGER
7 FOOD ✳ CHAIN
8 H
9 PRODUCER
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12 W
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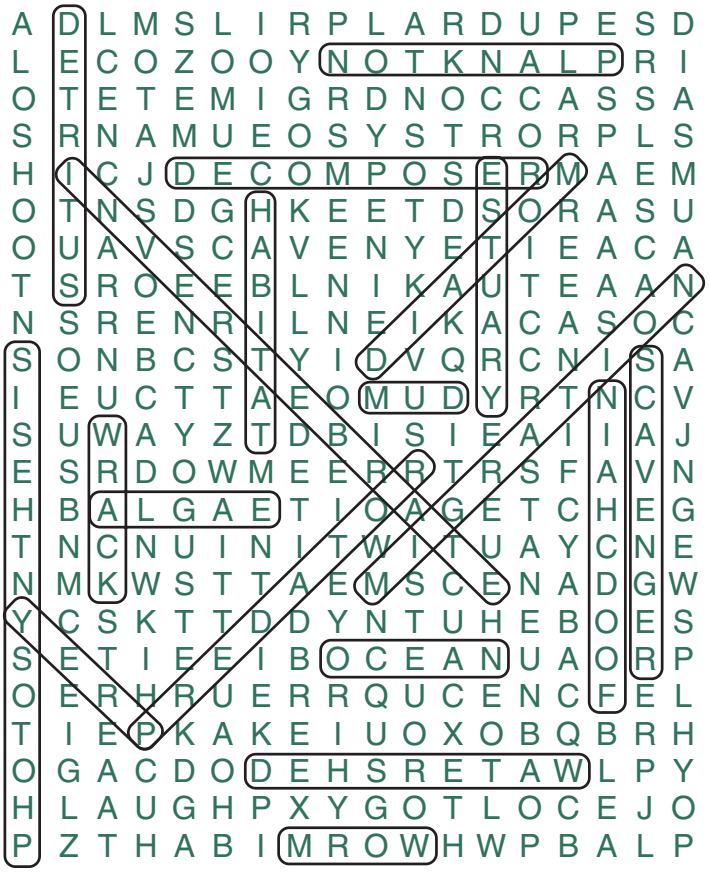
16 MIGRATION
17 ESTUARY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OUAVSCAVENYETIEACA
TSROEEBLNIKAUTEAAN
NSRENRILNEIKACASOC
SONBCSTYIDVQRCNISA
IEUCTTAEOMUDYRTNCV
SUWAYZTDBISIEAIIAJ
ESRDOWMEERRTRSFAVN
HBALGAETIOAGETCHEG
TNCNUINITWITUAYCNE
NMKWSTTAEMSCENADGW
YCSKTTDDYNTUHEBOES
SETIEEIBOCEANUAORP
OERHRUERRQUCENCFEL
TIEPKAKEIUOXOBQBRH
OGACDODEHSRETAWLPY
HLAUGHPXYGOTLOCEJO
PZTHABIMROWHWPBALP

Writing an Estuary Story

Write the best story you can using all of the words below. Be sure you know what they mean, then be creative!

estuary
plankton
phytoplankton
zooplankton
detritus
habitat
food chain
watershed
photosynthesis
producer
consumer
predator
prey
decomposer
scavenger
algae
diatoms
filter feeder
food web
invertebrate
migration
wrack

Learning About Tides and Tables

As a class, take a look at a tide table (available at hardware and sporting goods stores, and in some phone books.)

1. Estimate what the tide will be at 11:00 A.M. on the day of your trip to the beach. _____ Will it be going in or out? _____
2. The tidal range is the distance between the highest and lowest tides. Look at the May tide table, and find three consecutive days with a large tidal range. Now find three days with a small tidal range. Do the same for June. What is the pattern?_____
3. Look for times of low tide in June and times of low tide in December. What is the pattern?_____
4. If you are planning a trip to Padilla Bay, this is what you might expect to find.

   -2′ to 0′ tide - - the bay is nearly empty.

   0′ to 2′ tide - - large area of mud flat exposed.

   2′ to 4′ tide - - small amount of mud flat exposed.

   4′ to 6′ tide -- sandy beach and cobble.

   6′ to 8′ tide -- narrow beach

   What should you expect to see when your class is at the beach?
5. As a class, discuss how tides affect the animals that live in the estuary. How do different plants and animals deal with the changing tide? List:

   Animals that leave the bay at low tide.

   Animals that may come to the bay at low tide.

   Animals that close up at low tide.

   Animals that hide under rocks at low tide.

   Animals that burrow into the mud at low tide.

Bonus

What causes the tides?

What do you need in order to dig clams in December?

Make a Food Chain

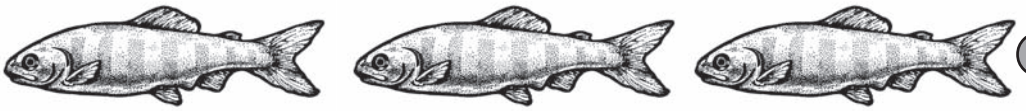
Each of the strips below makes a link in a food chain. Cut on the dotted lines and tape or staple the links together in the order you think is correct, beginning with the "producer."

Then start adding links of your own. As you add estuary eaters, your chain will quickly become a **food web.**

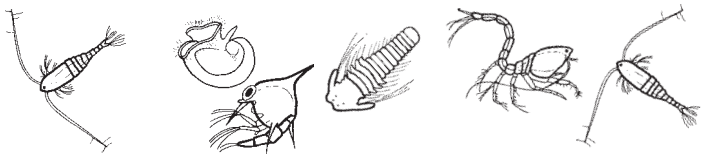
Extra: Add a link that says "Me" to a link that you like to eat.

Shrimp

Salmon



Zooplankton

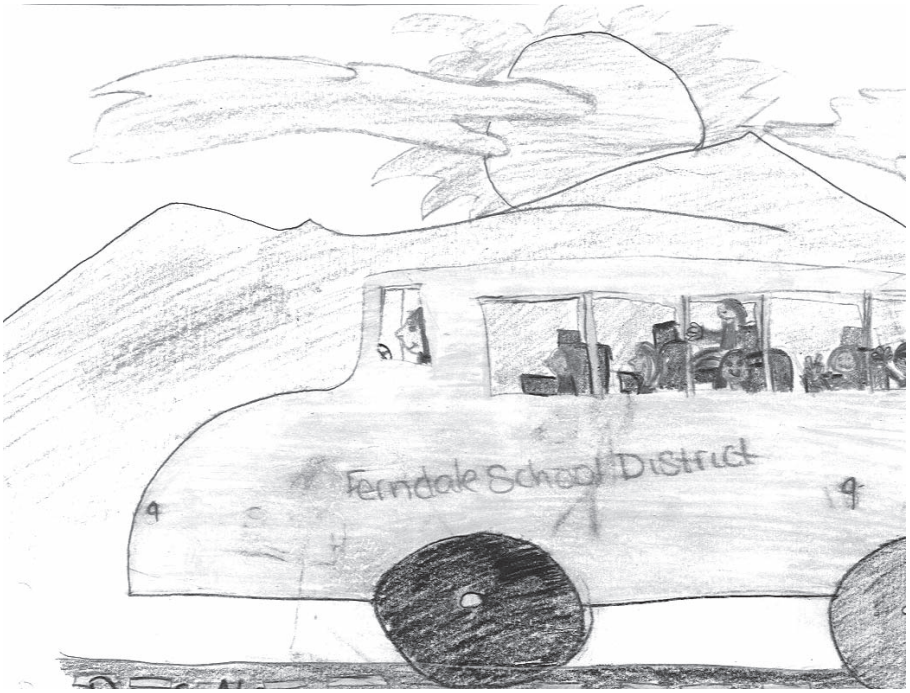


Phytoplankton

Eagle

Make a Food Chain

On Site



Important Notes

Welcome to Padilla Bay — students of all ages! Thank you for sharing your time in helping us carry out the day's activities. Your participation makes our program possible.

Clothing

A cool rain can smell rich, heighten the vividness of natural colors and be very refreshing, or it can turn a potentially invigorating day sour. A raincoat and warm clothes are essential. Layers of clothes help trap insulating air and are best for changing conditions. Hats and gloves are recommended from October to April. Old shoes that tie or snug boots are best for low tide days. Shoes that pull off easily can be a problem in soft mud. It's often windy and cold on the beach. Please be prepared for the worst and hope for the best!

Food

Eating a high-energy breakfast is a critical beginning to a day in the field. Please advise your class to eat heartily and bring a solid lunch with a "treat". We have nothing edible to offer here at the Center.

Schedule

The day's program is packed with a variety of activities, flexible enough to work within your time limitations. Our goal is to make the day meaningful to you. It will be most successful if we can complement your curriculum, so please feel free to discuss your specific needs and interests.

Schedule For The Estuary Program

9:30 - 10:30 - Welcome and Orientation

After a welcome outside, the group will meet in the theater for a brief introduction to Padilla Bay. Terms such as "estuary," "plankton" and "detritus" will be explained through a film and a short skit by the "Estuary Soup" chef.

10:40 - 11:45 - Mud Flat Safari

The class will head down to the water's edge. Teams of students, each with an adult leader, will explore the different habitats of the estuary by looking for plants and animals on the beach. We will collect plankton and a sample of organisms to investigate with microscopes in the afternoon.

11:45 - 12:15 - Lunch at Bay View State Park

12:30 - 12:45 - Water Drop Jungle: Plankton Viewing

The live plankton sample gathered at the beach will be projected onto a screen for all to view.

12:45 - 1:30 - Interpretive Exhibits

Students take in the exhibits at the Center. There are interactive displays about watersheds and the Padilla Bay estuary, a "hands-on" room for children of all ages, microscopes for individual use, and live saltwater aquaria.

1:30 - 2:00 - Chalk Talk History of NW Estuaries

The "chalk talk" presents human activities in a typical Northwest estuary. This leads to the wrap-up discussion of decisions students make which affect estuaries.

Simulation Game

This optional activity is used with older groups when time allows. Students role play various characters with conflicting interests, and make a decision about development of an estuary.

Parent Page

Thanks for your help!

We hope you gain as much from your visit as your child will. There are several times during the day when we need your help supervising a small group of students. One is during the beach exploration, and the other is during the exhibit tour.

Exploring the Beach

At the beach, your group will have clear instructions and boundaries. Your job will be to keep them together and on task.

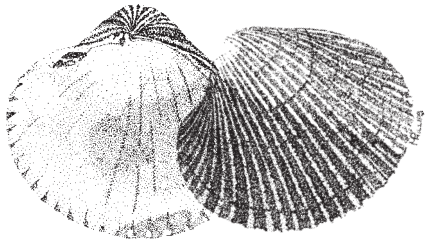
When your group brings something to you and asks, "What is this?"— don't worry about knowing the name. Rather than naming, try returning a question. "Where did you find it? What do you think those feathery things are? Does it have a head? Can you find the name on the field identification sheet?" Open-ended, stimulating questions involve the children and encourage discovery. This trip is about sharing your enthusiasm, watching the excitement of children, and exploring with them.

Ouch! Ouch! Be the voice of the plants and animals when students, in their eagerness, get careless. Try to impart an ethic of care and responsibility. Be sure that students leave everything they find at the beach. Help by picking up any garbage you may find. Your example is very important!

Please help us keep the State Park facilities clean by checking restrooms and picnic shelter for litter.

Exhibit Tour

You will also be supervising your group during the exhibit tour. Please remind your students about proper indoor behavior. Interactive exhibits are sturdy, but not indestructible. Make sure students are treating exhibits with respect. In the aquarium room, ask students to not tap on the glass. The vibrations disturb the aquarium animals.



Aquaria Inquiry

Teachers and adult leaders can use these questions to focus students' attention in the aquarium room.

1. Find an animal that can: squeeze through narrow places. . . hold still and look like a rock . . . bury itself to hide from predators . . . use another's shell for a home.

2. Find 3 animals in the eelgrass that are camouflaged. With your group vote on the "Best Camouflaged" eelgrass inhabitant. Discuss how camouflage aids in survival.

3. Think of 3 adaptations that help animals avoid being eaten (close up, bury, camouflage, sting, pinch, have spines).

4. Find one fish that swims constantly and one that rests on the bottom. Think of an advantage for each style (keep moving to avoid being eaten, blend in).

5. Choose your favorite animal and make up a name for it.

6. Think of waves pounding on rocks. What are some adaptations to help animals survive this pounding? (hard shell, suction for holding on, ability to hide under rocks and in sand)

7. What bird can probe deep in the mud for its dinner? (shorebird) What enables it to do so? (long bill) What might it feed on? (worms, small clams, snails)

8. Hermit crabs are scavengers, searching out and eating wounded or dead things. They help to "recycle" nutrients in an estuary. Can you find dead things in the tanks?

9. How many different species of seastars can you find? Look for tube feet.

10. What are 3 animals adapted for living in the mud? (shrimps, clams, worms) Give a unique adaptation for each that aids it in living "down under." (see wall model)

11. What makes eelgrass different from seaweed? (reproduces by flowers, has roots not holdfasts, leaves not blades, anchors in mud not onto rocks) Why is eelgrass so important to animals? (food, habitat, source of detritus)

12. Why do some raptors (birds of prey) live by estuaries? (abundance of food: shorebirds on mudflats, fishes in water, small rodents in nearby fields)

13. Find out which birds, fishes and mammals live in marshes.

14. How do nutrients from eelgrass get recycled? (bacteria and fungi feed on the dead grass and break it down. These particles are in turn food for plankton and detritivores)

15. How many animals can you find that have hard shells on the outside of their bodies? (snails, clams, barnacles, limpets, shrimps) How does this help them survive? (protection)

by Pam

On Your Own At The Beach

Beach Etiquette

Estuaries are valuable habitats, easily damaged by careless exploring. Please discuss with your class the ways to be careful with this important resource.

A technique we use here at the Padilla Bay Interpretive Center is called the Magic Bag. Children reach into a bag for objects that remind us of ways to be careful and respectful. A rock with a barnacle shell attached to it reminds us to step lightly and carefully return rocks to their original position. A toy shovel reminds us to fill in holes. A limpet shell reminds us to leave limpets safely attached to their rocks, and a piece of litter encourages children to pick up garbage. Be sure your students know these rules.

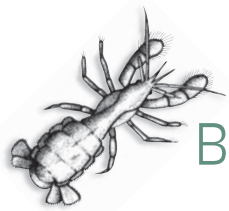
Equipment

We use shovels, plastic jars, and dissecting trays to help students find animals, focus attention and share their discoveries. (One set of equipment for every 5-8 students is adequate.) This equipment is not necessary, but is helpful. Feel free to use any of the following Scavenger Hunt lists to help your group in their exploration. Students should handle animals as little as possible and return all animals to their appropriate habitats.

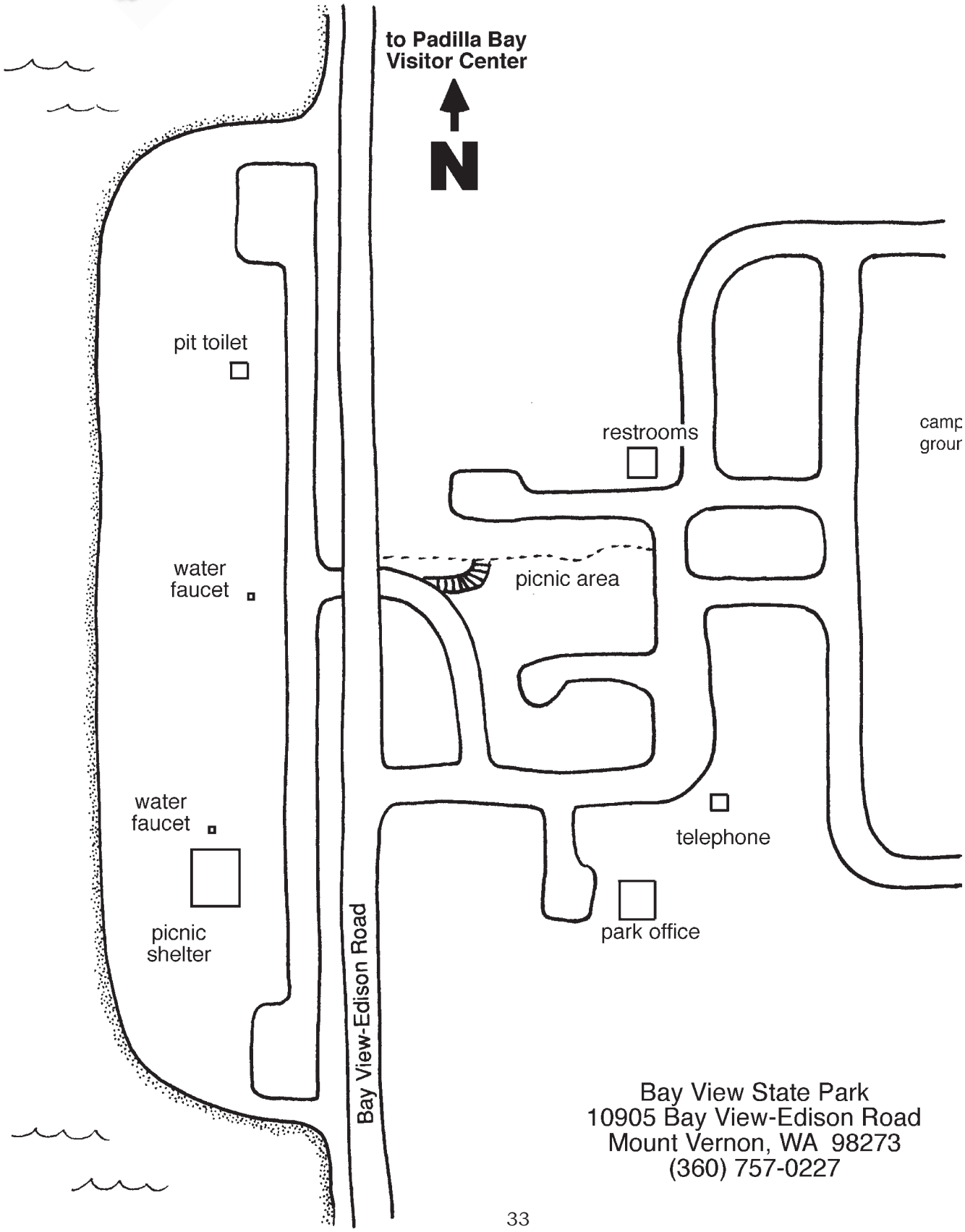
Cleanup

High tide cleanup is as simple as wiping off loose sand and perhaps changing wet shoes. Low tide in Padilla Bay means mud. Setting clear expectations is important. Each teacher has his or her own "tolerance level" for how much mess is allowed. Be sure your students know what you expect. You should expect muddy shoes -- not necessarily muddy or wet clothing.

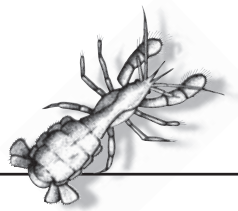
Several dishpans of water and a hose help reduce congestion and clogging mud at the faucet. Please wash up at the faucet at the beach, not in the rest rooms. Check for litter before you leave. Your help in keeping the picnic area and rest rooms clean will insure that we continue to have access to this fine facility and the State Park staff will appreciate your efforts.



Bay View State Park



Bay View State Park
10905 Bay View-Edison Road
Mount Vernon, WA 98273
(360) 757-0227



Padilla Bay's Scavenger Hunt

☐ Clamshells: ☐ with ridges ☐ without ridges

☐ 4 different kinds of birds: 1 _____

2 _____ 3 _____ 4 _____

☐ 2 kinds of eelgrass: ☐ ☐

☐ 2 kinds of algae: ☐ ☐

☐ An animal track

☐ Something that changes _____

☐ Something slimy _____

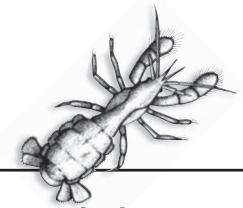
☐ 2 kinds of crabs: ☐ ☐

☐ 3 unique smells: ☐ ☐ ☐

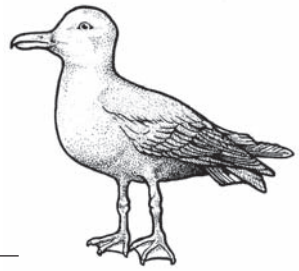
☐ 2 different mud dwellers: ☐ ☐

☐ Signs of human influence: ☐ ☐ garbage

Please return *all* critters to their homes when you're done, replace rocks, and fill in holes.



Low Tide Hunt



__ 2 bivalves (with hinged shells) _____ _____

__ 4 birds _____ _____ _____ _____

__ 2 gastropods (snail and slug family) _____ _____

__ 2 different kinds of eelgrass _____ _____

__ a red algae

__ a green algae

__ a brown algae

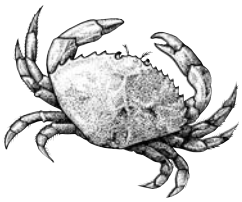
__ 2 animal tracks _____ _____

__ 3 mud dwellers _____ _____ _____

__ a detritivore (eats detritus)

__ 2 kinds of crabs _____ _____

__ a crab molt (a shed shell)



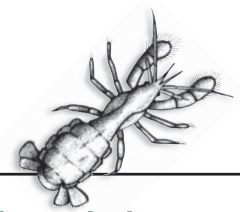
__ 2 unique smells _____ _____

__ 2 epiphytes (living on a plant) _____ _____

__ 1 filter feeder

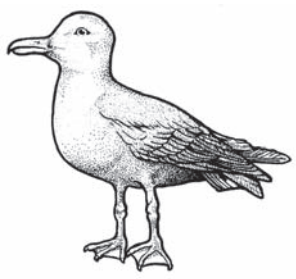
__ a sponge

__ garbage



High Tide Hunt

__ 2 different bivalves (hinged shells)



__ 4 different birds

__ 2 different gastropod shells (snails, limpets)

__ 2 different eelgrass species

__ eelgrass with epiphytic algae

__ eelgrass with Spirorbis (snail worm) casings

__ eelgrass with bryozoan colonies

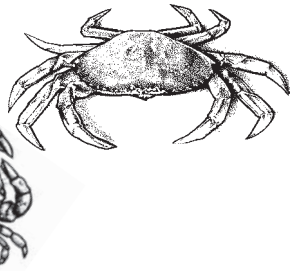
__ a red algae

__ a green algae

__ a brown algae

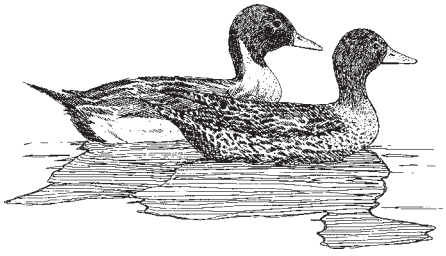
__ an amphipod

__ a crab molt (empty shell)

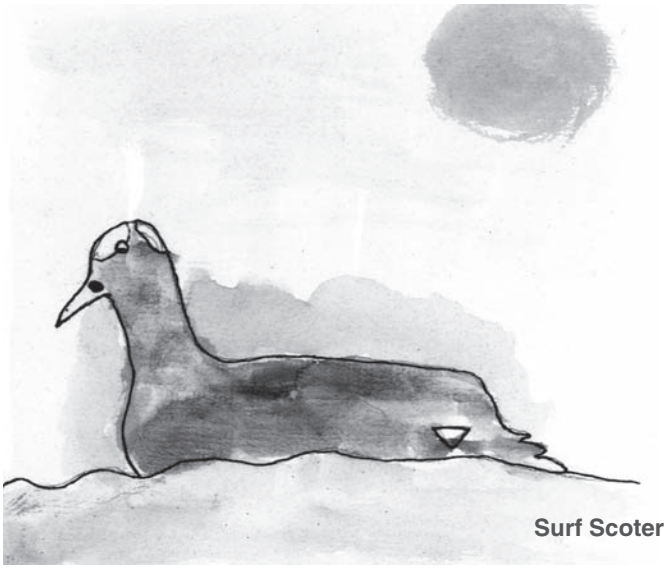


__ 2 unique smells

__ 4 Signs of human influence



Post Trip



Surf Scoter

Critter Creations

Research and create an estuary animal or plant.

Ask each student to choose one animal or plant from the list below. Using resources from the library have students research:

a) what their organism looks like

b) where it lives

c) how it fits into the food web.

Using modeling clay, instant paper maché or home-made clay, have them shape their animal/plant, let it dry, and paint it. Follow-up activities may include written and oral presentations, or a class project building an estuary diorama.

Invertebrates
jellyfish
anemone
ribbon worm
lugworm
sand worm
barnacle
amphipod
eelgrass isopod
mud shrimp
hermit crab
Dungeness crab
shore crab
sponge
limpet
mud snail
bubble shell
bent-nosed clam
little neck clam
mud clam
mussel
oyster
sea star

Fishes
herring
salmon
surf smelt
bay pipefish
three-spine stickleback
shiner perch
sculpin
flounder
gunnel

Birds
common loon
great blue heron
black brant
mallard
sandpiper
dunlin
peregrine falcon
bald eagle
gull
bufflehead

Plants
eelgrass
algae
phytoplankton
salt grass
pickleweed

Mammals
river otter
harbor seal
muskrat

Afternoon In An Estuary

This is a creative drawing (and listening) exercise to be read aloud to your class as they draw.

Imagine that you are in a boat going down a river. After two hours of going downstream, you come to the mouth of the river where it meets the ocean. This area, where fresh water from the river meets the salt water from the ocean, is called an ESTUARY. In the center of your paper near the top, draw the boat on top of the water in the estuary . . .

Although the estuary will be deep where the main channel of the river is, it will be shallow along the shore and in much of the estuary itself. Draw some areas of shallow bottom under your boat . . . Now draw yourself lowering an anchor to measure the depth of the estuary . . . Leave the anchor on the bottom so the next tide does not carry you away. Now you have time to look down into the water.

Because the water is so shallow in an estuary, a lot of sunlight can get through the water to the plants that grow on the bottom. The river that flows into the estuary carries soil from the land, bringing lots of nutrients for the plants to use for making food. These nutrients, along with the sunlight and shallow water, allow many plants to grow. Draw lots of algae and eelgrass on the estuary's floor . . .

Many estuary plants are so tiny that one needs a microscope in order to see them! These plants are eaten by tiny animals. The tiny plants and animals that live suspended in the water are called PLANKTON. Draw lots of these microscopic plants and animals in the water under your boat . . .

Many animals like clams, mussels, barnacles and sponges eat this floating food by filtering it from the water. Draw some of the filter-feeders on the bottom of your estuary . . . When animals and plants die, they drift to the bottom and decay, becoming DETRITUS. Some kinds of worms eat this decaying matter. Draw several worms living in the muddy bottom . . .

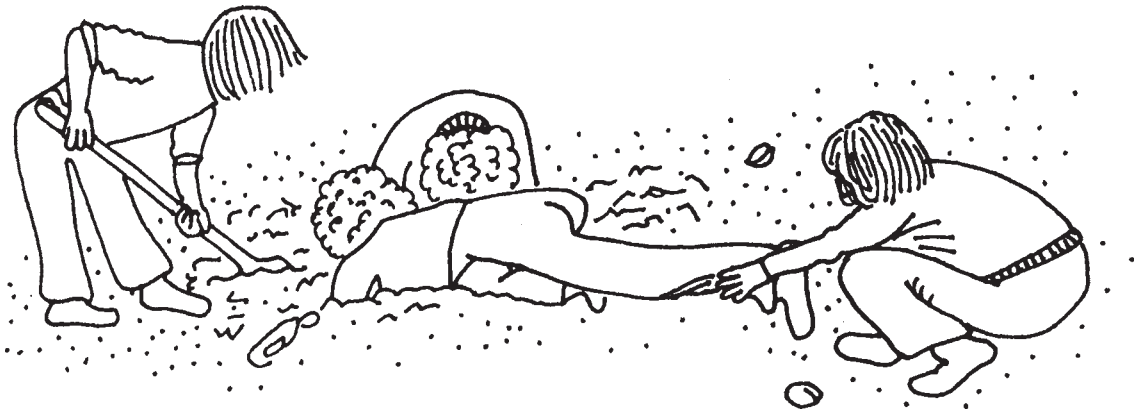
Afternoon In An Estuary

Small fish not only find food in an estuary, they can also hide from predators in the algae and eelgrass. Draw lots of little fish, feeding and hiding in the plants . . . Because there are so many little fish, larger fish will live in an estuary. Draw a large salmon looking for a tasty meal . . . Now draw an animal that might eat a salmon — for example, a harbor seal or bald eagle . . . Now that you know there are large salmon in your estuary, you are getting hungry. On the back of your paper, draw yourself eating a tasty meal from an estuary . . .

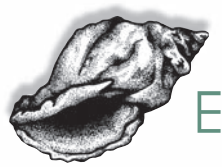
Adapted from "Clean Water, Streams, and Fish",
Washington State Office of Environmental Education

What's Happening Here?

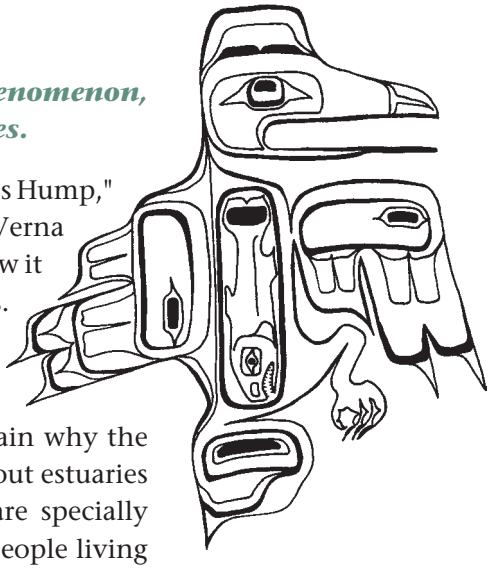
Use your imagination. Look at this picture and write a story describing what is going on. Don't forget a title for your story.



Thanks to the Poulsbo Marine Science Center



Estuary Stories



Read or tell a story that explains a natural phenomenon, and then let the students create their own tales.

Rudyard Kipling's *Just So Stories* ("How the Camel got its Hump," etc.) and *Why Mosquitoes Buzz in People's Ears,* by Verna Aardema, are familiar examples of stories that tell "how it came to be." Choose a story to read aloud to your class. Collections from other cultures are good sources for such a tale.

Introduce the story by talking about tales that explain why the world is the way it is. After reading the story, talk about estuaries and how they work so well. Name animals that are specially adapted to live in their estuary habitat. Talk about people living near and using estuaries. Imagine what it would be like if estuaries or estuary animals were different, perhaps not so well adapted.

Have your students create their own stories about something in the estuary. (How the crab came to have claws, the great blue heron's long legs, why worms burrow into the mud, why the river always runs down to the sea, etc.) Send copies of your stories to Padilla Bay. We'd love to share them!

An excellent "estuary tale" is the Tahtlan story from Northern British Columbia which explains the tidal cycle. "Why the Tides Ebb and Flow" is the story of how Raven provided food for the people by making intertidal plants and animals available to them. Raven discovers a great big man sitting on a hole in the earth. If the man gets up, the water pours into the hole, the tide goes down, and people have food. By placing sharp rocks under the man, Raven convinces him to stand up twice every day, long enough to let the water recede so that the people can gather seafood on the shores.

"Why the Tides Ebb and Flow" can be found in the book, *How the People Sang the Mountains Up*, by Maria Leach, published in 1967 by Penguin Books. It is also available in the collection, *Wetland Tales*, published by Washington State Department of Ecology. Call the Publications Office at (360) 407-7472 for a free copy (Publication No. 92-17).

The Salmon Gazette

Create a student newspaper with a salmon theme.

Creating a newspaper is a great interdisciplinary tool for in-depth exploration of a topic. Students draw from their studies as well as from their lives and local environments to gather information, compiling it into a creative product to share.

Salmon are very much "in the news" these days. Their dwindling populations, their dependence on many different habitats throughout their life cycle, and their strong place in Northwest culture, all make salmon an excellent topic for study.

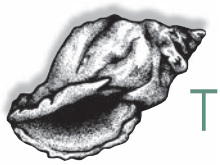
Study the local newspaper with the group. You might also arrange to take a trip to a newspaper office or invite a news media representative to speak to your students. This will allow them to see how complex the news-gathering process is. If your school has its own newspaper, consult with the staff for resources and advice, or invite the staff to work with you to produce your “Gazette”.

Organize students into four or more news departments. Ask each department to discuss types of stories and headlines they can write. Examples of departments and sample topics are listed on the following page. Illustrations or photographs should accompany the stories.

Plan to distribute the newspaper locally in school and perhaps also in the community. Contact the local newspaper to see if the editor will print one or two of the better stories.

Finally, review the newspaper with the students. Question them about salmon issues. What have they learned about publishing a newspaper? What was the biggest problem they encountered and how did they solve that problem?

Adapted from *Wetlands Conservation and Use*
U.S. Fish & Wildlife Service.



The Salmon Gazette

Departments	**Sample Topics**
Local, Regional, and National News	-logging, farming, and development in the watershed that might affect salmon -related science news; research findings -health of local salmon stocks
Editorials	-opinions about actions to help salmon -letters to the editor
Sports & Recreation	-salmon runs, good observation spots -fishing regulations and hot spots
Community Events	-watershed cleanups -stream restoration activities -local meetings
Art & Culture	-illustrations, poems or cartoons about salmon -interview a local wildlife or fish printing artist -native designs with a salmon image -storytelling
Food	-salmon and seafood recipes -interviews with restaurants that serve salmon
Advertisements	-ads for salmon-related businesses, e.g. smoked salmon, sporting goods stores -help wanted ads for related jobs
Travel & Leisure	-estuaries to visit around the state, country or world
Weather	-el niño -floods -drought

Salt Water - Fresh Water

Investigate the properties of salt and fresh water.

You can use real samples from the sound and a nearby stream or river, or make samples in your classroom.

Salinity

Ocean water is about 35 parts per thousand salt. That's about one teaspoon in a cup of water. Boil salt water and fresh water and weigh the residue remaining.

Density

Use a hydrometer (available at aquarium stores) to measure water density. What happens to the hydrometer as salinity increases?

Salinity

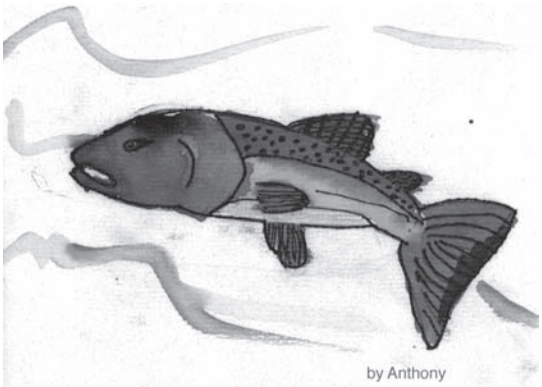
Salt water is denser than fresh water. Use food coloring to show what happens when you slowly pour one into the other. Place an egg in a container of fresh water. Guess how much salt you need to add to make the egg float and then test your guess. Ask your students if they would expect to find higher salinity at the surface or the bottom of an estuary?

Osmosis

Soak 4 eggs in vinegar overnight to remove the shells. Being careful not to break the membranes, place one egg in salt water and one in fresh or distilled water. (The others are extras in case of accidents.) Observe the changes over the course of a day. Ask students to guess why. Osmosis is the movement of a substance across a membrane from an area of higher concentration to an area of lower concentration.

Adaptations

Talk about animals and salinity. List plants and animals that are found in fresh water and those found in salt water. Make a Venn Diagram to show which occur in both. What problems do these organisms face? Check library resources to find out how salmon cope with the change from fresh to salt water.

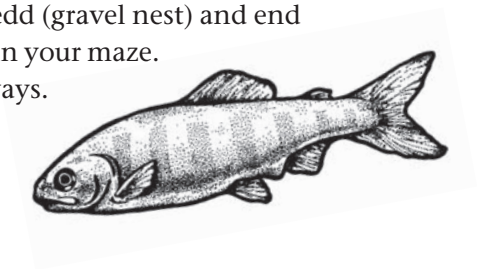


Salmon Maze

Make your own salmon maze.

Life is not easy for a young salmon. Young salmon traveling down river must pass all sorts of hazards. Out of 2,500 coho salmon eggs, only 6 fish will ever make it to the ocean!

Use ideas from the list of places and hazards below to make your own maze. Start with young salmon in their redd (gravel nest) and end with the ocean. Put hazards at dead ends in your maze. Put good conditions along correct pathways.



Stream

Ocean

Estuary

River

Delayed by slow flow in reservoir

Eaten by gull after it goes over a dam spillway

Killed in power turbine of dam

Trapped in an irrigation ditch

Swim into oil poured down a storm drain

Gills choked with mud and silt from construction site

Eaten by raccoon

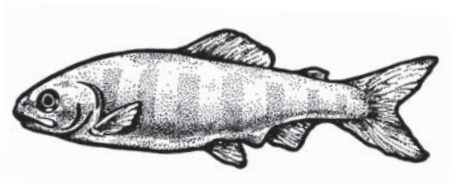
Low oxygen in warm water because of no shade trees

Clean river water

Shrubs and trees growing along stream

Woody debris on stream bed

Healthy eelgrass meadow to hide in

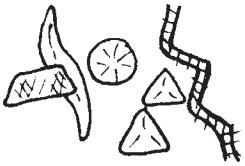


Now copy your maze and share with friends!

Food Chain Game

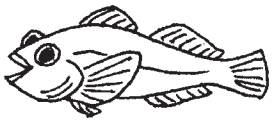
Students role play an estuary food chain to learn about energy transfer and the challenges facing estuary animals.

The food chain in this game consists of four links:



phytoplankton (popcorn)

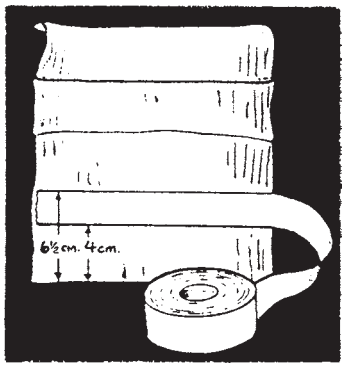
zooplankton



sculpins

great blue herons

Popcorn represents the phytoplankton. Students play the roles of zooplankton (plant eaters), sculpins (which eat zooplankton), and great blue herons (which eat the sculpins). Each student tries to get enough to eat without being eaten during the timed course of the game.



You will need:

- 1 large paper bag of unsalted popcorn
- 1 timer
- roll of 1" masking tape
- 1 plastic sandwich bag (stomach) for each student. Place a strip of masking tape parallel to the bottom of the bag, $1^1/_2$" from the bottom.
- color coded "sashes" (fabric or paper) For every 3 students, make 2 zooplankton sashes, 1 sculpin sash, and 1 great blue heron sash.

How to play:

1. Briefly review food chains. Outline the boundaries of the game area, an area big enough for a controlled game of tag. This game is best played outdoors or on an uncarpeted area.
2. Spread the phytoplankton (popcorn) over the area. Tell your class you are spreading out the phytoplankton for the zooplankton to eat.

Food Chain Game

3. Divide the students into 3 groups and distribute the sashes and plastic bag stomachs. Give one group **zooplankton** sashes and tell them they need to fill their plastic bags with popcorn to the bottom of the tape to survive. Give a second group **sculpin** sashes and instruct them to fill their bags to the top of the tape. The third group gets **great blue heron** sashes and must fill their stomach to the top to survive. Great blue herons tag sculpins. Sculpins eat zooplankton, and zooplankton eat the phytoplankton (popcorn). If a great blue heron tags a sculpin the sculpin must surrender the contents of its stomach and leave the game. If a sculpin tags a zooplankter, the zooplankter must surrender the contents of its stomach to the sculpin and leave the game.

4. Set the timer for five minutes and "GO!" The first game usually lasts only a few seconds with one of two things happening. The zooplankton are gobbled up before they have a chance to forage, or the sculpin are gobbled up and the zooplankton continue to eat popcorn.

5. Record the number of each kind of animal that survived. Have students suggest rules that might allow all four links of the chain to still have survivors after five minutes of play. Suggestions may include:

   a. Change the ratio of zooplankton to sculpins and herons.

   b. Let each zooplankter come back as another zooplankter once after being captured and transferring its stomach contents.

   c. Provide a "safety zone" for zooplankton and /or sculpins.

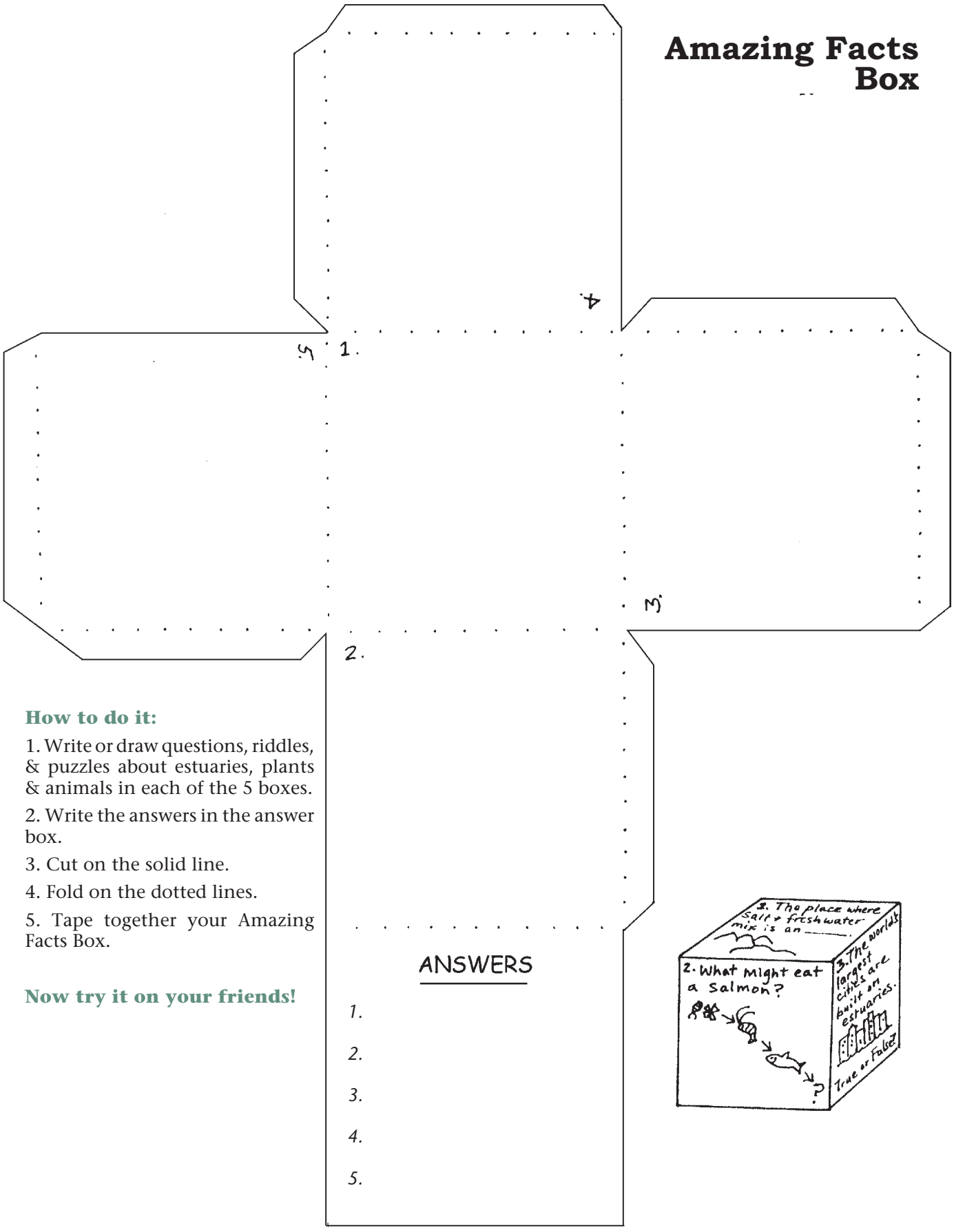
   d. Timed releases. Let zooplankton go first to forage. After one minute, release the sculpins, and then one minute later, the herons.

6. Replay the game and modify your rules several times until a balance is achieved.

Conclusion: Analyze the results of each game. Compare this game to a real food chain. How are your rules similar to or different from how it really works?

How about making extra popcorn to eat?!

Amazing Facts Box



How to do it:

1. Write or draw questions, riddles, & puzzles about estuaries, plants & animals in each of the 5 boxes.
2. Write the answers in the answer box.
3. Cut on the solid line.
4. Fold on the dotted lines.
5. Tape together your Amazing Facts Box.

Now try it on your friends!

ANSWERS

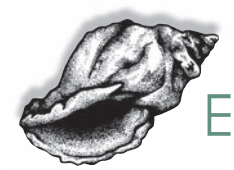
1.

2.

3.

4.

5.



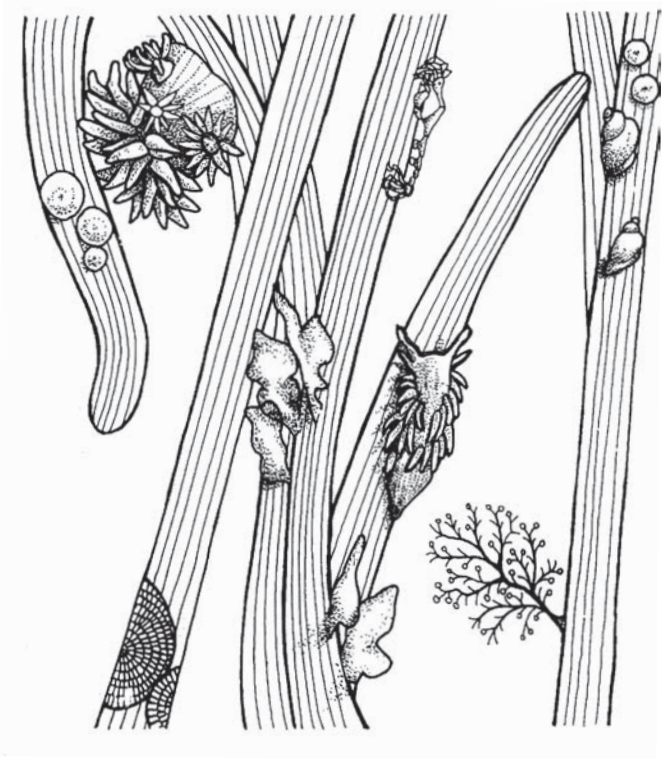
Estuary Community Dance

It's a party, and all the plants and animals are invited. Like a community dance, this activity gives students a chance to get to know the members of an estuary community a little better.

Copy the cards on the following pages. Pin a card on each student's back and challenge the class to find out "who" they are. Students can mingle freely, asking only yes and no questions to gather information about the plant or animal on their back. When all the students have guessed correctly, mix the cards and repeat with new critters.

You may want to set the stage properly with snacks, music, lights, etc., to make the event festive.

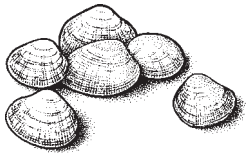
This is an excellent activity to close your study of estuaries, or to follow up class presentations from the activity, Critter Creations, on page 37.



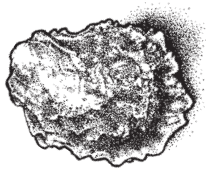
I'm proud to be a **GREAT BLUE HERON**. Just look at my graceful long neck, powerful pointed beak, and great legs! What could be better for hanging out in shallow water and catching fish? Estuaries are good places for me to find food, but I also like ponds, rivers, wetlands, ditches -- anywhere wet. You'll never catch me swimming. I'm strictly the wading type.

I'm the dead stuff, **DETRITUS.** I may not be a "critter" but I'm SO important, SO connected to everyone, and SO teeming with bacteria that I definitely belong at this party. I'm bursting with stored up energy. You can think of me as the corner grocery. My bacteria are munching away, unlocking goodies for everyone else to enjoy. I give the mud that beautiful color. My bacteria contribute to the lovely smell.

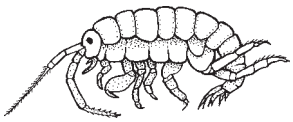
I'm a bent-nose **MACOMA CLAM.** Don't you think I'm well adapted to life in the mud flat? I'm thin enough to slip into the thick mud. My two siphons are just what I need to suck detritus off the mud surface and spit out the inedible particles. I'm a lovely mud-gray color so I'm hard to spot by hungry gulls. I don't have any eyes, so life down under doesn't bother me a bit.



LITTLENECK CLAM means that I can't burrow very deep. My short neck has to be within reach of the mud's surface. I suck in the water through my siphon and filter out the plankton and detritus. Gulls really like me because they don't have to dig far to find me. People like me for the very same reason. When the tide is low, I just pull in my neck, close up tight, and wait for the water to return.



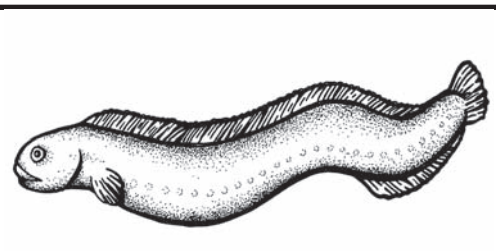
I'm an **OYSTER,** and I love estuaries. In fact, you won't find me anywhere else. In Washington, I'm a big money maker for shellfish growers. I have to have clean water, though or people can't eat me. Like clams and mussels, I filter plankton and detritus from the estuary water. In fact, I can filter 25 gallons of water each day. That's a lot for a little animal like me!



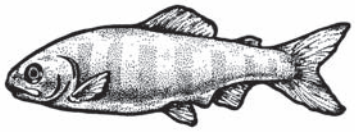
I am an **AMPHIPOD.** I am about the size of a house fly. I eat dead eelgrass which has washed up onto the shore, but other kinds of amphipods may eat things like smaller crustaceans (crab relatives), green algae, or diatoms (phytoplankton). I don't like fish such as salmon, perch, or herring, but they sure like me (to eat)!

I'm a **HARBOR SEAL** and although my big eyes make me look "cute", I'm really a large predator with fierce teeth. I eat over twenty species of fish in Puget Sound with my favorites being sculpin, herring, and hake. You can tell me apart from other marine mammals by my small size, spots, and lack of external ears.

You can call me **MUD SNAIL,** although **BATILLARIA** is my true name. I'm a foreigner, imported from Japan, and I really love my new home. There's detritus everywhere for me to eat, and the mud is covered with microscopic plants called diatoms. Yum! I don't worry about drying out on sunny days. Even when the tide is low, the mud stays nice and wet, and I can always close my operculum if it gets too dry.

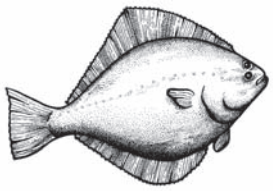


I'm a **GUNNEL,** one of several different species of gunnels found in Padilla Bay's eelgrass. Some people see my long, thin body, and think I'm an eel, but I'm not. Some gunnels can get to be a foot and a half long though 6"-10" is more common. I eat smaller animals like snails, clams, and little crabs.



I'm a young **SALMON SMOLT.** I'm one of thousands of migrating juvenile Chinook, coho, pink, and chum salmon that come down to the estuary from rivers and nearby creeks. I use the estuary as a place for my body to adjust to the salt in the ocean. And I chow down on copepods and amphipods (plankton) living on or near the bottom. Estuaries are good places to hide from big fish, too.

I'm a **THREESPINE STICKLEBACK,** and I hang around estuaries because I can handle both fresh and salt water. You might find me hiding in the eelgrass meadow eating smaller fish, tiny crustaceans, and plankton. If a predator threatens me, I'll stick up my sharp dorsal "spines." I especially need to watch out for bigger fish, seals, and birds.

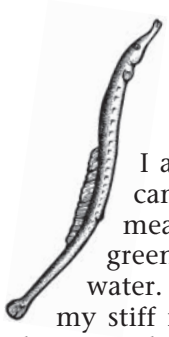


I'm a **STARRY FLOUNDER,** hard to see when I lie flat on the mud. Like most fish, I'm born with an eye on each side of my head. After about 2 weeks, one eye begins to “migrate” to the opposite side of my head, and I lie down on the eyeless side. I skim along the mud flat eating crustaceans, worms and small fish. When I'm young, skeleton shrimp are my favorites to munch.

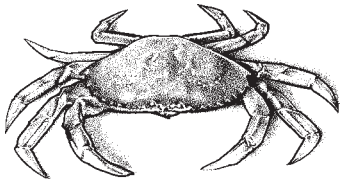
I'm a **HERMISSENDA,** a nudibranch. I must be the most beautiful animal here. I glide gracefully around the meadow with my cerrata (the frilly things sticking out of my back) rippling in the current. Those cerrata are my protection, for they contain stinging cells which taste bad to almost everyone. I like to eat eggs, little snails, other nudibranchs, bits of dead stuff -- most anything, in fact.

I am **EPIACTUS,** a brooding anemone. I attach myself to the blades of eelgrass where I sit and wait for plankton or detritus to touch my tentacles. I am green, like the eelgrass. I can move around, but I don't go far or fast. My babies attach to my side, so people call me a **brooding** anemone. I'm food for some nudibranchs (sea slugs) and sea stars.

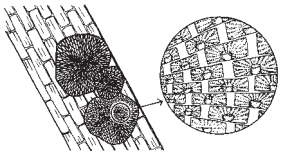
I am a **CAPRELLID AMPHIPOD.** People sometimes call me a skeleton shrimp, but I'm definitely not a shrimp. I inch my way along the eelgrass, scraping up diatoms, bacteria, and algae living on the blades. I'm prime fish food, so I hold tightly onto the eelgrass with my hooked "feet." I might win a prize for the most bizarre looking creature in the community.



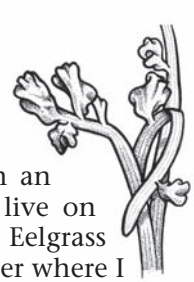
I am a **PIPEFISH.** I am perfectly camouflaged to live in the eelgrass meadow. I am long and thin and green, and swim vertically in the water. I eat plankton which I suck into my stiff mouth like a vacuum sucks up dirt. I need to watch out for larger fish and hungry crabs. My mother laid her eggs in my father's brooding pouch where I was incubated. I emerged looking like a tiny pipefish. I'm a year-round resident.



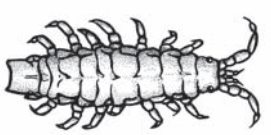
I am a small **DUNGENESS CRAB,** far too small for a crab pot. I grow pretty fast, but my skeleton is on the outside of my body so I have to molt my old shell, and grow a bigger one. The eelgrass offers me lots of hiding places, something important when diving ducks, great blue herons, and other crabs come around. My favorite foods are smaller crustaceans, clams, small fishes, and worms.



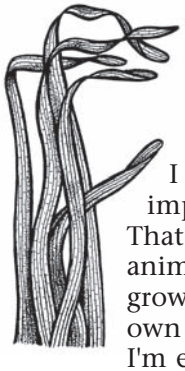
I am a **BRYOZOAN.** I live in a tiny box like case among thousands of other animals like me. My colony grows on algae or eelgrass to form a white, crusty patch the size of a quarter. I eat plankton which I catch with my tentacles. I'm not rare, I'm just small and hard to spot. Next time you go to the beach, check out algae and eelgrass that washes onto the beach, and you may find me.



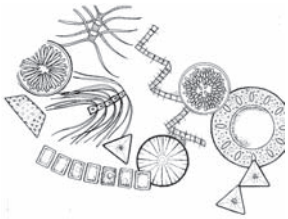
I am **an ALGAE,** living on an eelgrass plant. (Plants that live on other plants are *epiphytes*.) Eelgrass holds me high up in the water where I can get the sunlight to make my own food. (That's photosynthesis!) I am food for animals like snails, amphipods, and sea slugs. If I grow too big, I may harm the eelgrass by blocking its sunlight. If my eelgrass gets eaten by a brant goose, I get eaten, too.



I am an **EELGRASS ISOPOD,** an eelgrass eater and a pretty good swimmer. I zip along from blade to blade, watching out for predators (fish). When I cling to an eelgrass blade, even the most observant fish (or human) can't see me unless I move around. I'm about an inch long and exactly the same width as a blade of eelgrass. When I was born, I rode around on my mother's back until I was big enough to take care of myself.



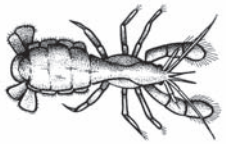
I am **EELGRASS,** the most important member of the bay! That's because lots of plants and animals live on or around me. I grow up to 10 feet tall, making my own food from the sun's light. Then I'm eaten by geese, ducks, isopods, snails, amphipods. . . I keep up by reproducing with both seeds and an underground stem that spreads and sends out new shoots.



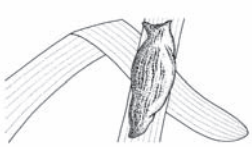
I am a **DIATOM,** a microscopic algae that can live floating in the water, coating the mud surface, or stuck to eelgrass blades. Much of the oxygen in the bay came from my photo-synthesis. I reproduce by splitting in half -- pretty easy! If I get too thick on the eelgrass, I can harm my host by stealing all the sunlight. I'm eaten by lots of animals who scrape me off the blades (snails, sea slugs, skeleton shrimp).

I am a **HYDROID** that looks a bit like algae. Actually, I'm made up of lots of cooperating animals. Some of us hold on tightly to the eelgrass blade. Some of us transport food up and down the colony. Some of us are the hunters, catching plankton with stinging tentacles. Some of us produce the "baby" hydroid medusae which float around like jellyfish until they find a good place to settle down.

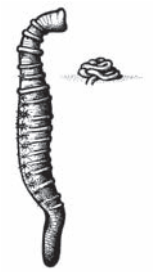
I am **LACUNA,** a very tiny snail that eats eelgrass and the algae attached to it. I am eaten by sea slugs and larger snails, but my hard shell keeps fish away. There is a tiny amphipod that tries to look and act like me so that fish will leave her alone, too. I lay my yellow eggs in donut-shaped rings on eelgrass blades. When danger is near, I close up tight and hope for the best.



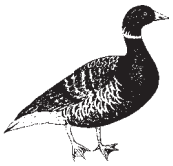
I am the “excavator” of the mud flats, the **MUD SHRIMP.** I dig extensive burrows in the subtidal and intertidal mud which are then used by many other organisms. I'm about 3" long with a soft, bluish shell. I use my feathery pinchers to trap detritus loosened by leaflike “spinnerets” under my abdomen. Clams, worms, crabs, copepods and isopods may share my burrow.



I am **PHYLLAPLYSIA,** a beautiful, green sea slug. (Some people call me Taylor's sea slug.) I glide along the eelgrass, scraping up the layer of diatoms and other microscopic organisms that cover the eelgrass blades. I look like eelgrass, long and green with stripes that mimic the eelgrass ribs. I lay my eggs in a clear, rectangular patch right on the blades. It seems that I taste so bad that nobody else in this community is interested in eating me.

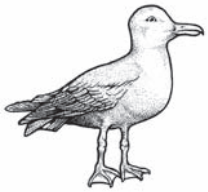


I'm a **LUGWORM,** a mud eater and burrower. I look a bit like an earthworm, but with little red gills sticking out along my sides. I eat the detritus in the mud and leave squiggly castings on the mud surface. Being a worm, I am food for birds and fish.

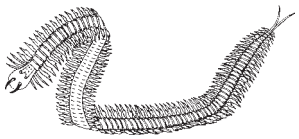


I am a **BLACK BRANT GOOSE,** a winter resident of the eelgrass meadow. I migrate between Mexico and Alaska, stopping at eelgrass meadows along the way to munch on those tasty eelgrass blades. Padilla Bay is one of my favorite stops because it has so much food for me. Some of my friends spend the whole winter here before travelling north for breeding season. I try to avoid humans and eagles.

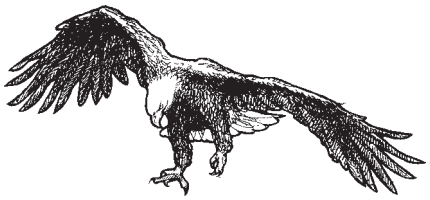
I am a **PERIWINKLE** or *Littorina*. Look for my small, black, round shell on rocks high in the tide zone. I prefer to be just out of the water, feeding on microscopic algae as well as bigger plants like sea lettuce. I can survive long periods out of water.



I am a **GULL,** the noisiest animal in the community. But I can't help it. I get so excited when the tide goes out and there is so much food to fight over. I eat crabs, worms, clams, fish, garbage -- just about everything! You may have seen my funny way of eating a clam. I fly up into the air and drop the clam, hoping to hit a rock. When the clam hits, its shell breaks and I have a feast.



Just call me **POLYCHAETE** (sounds almost like parakeet). I'm a lovely worm with lots of segments and leg-like things sticking out. You may find me digging around under rocks or in the mud, looking for food. Though my jaws look fearsome, they are mostly just for tearing algae. Birds like to eat me, so I try to stay hidden during the day.



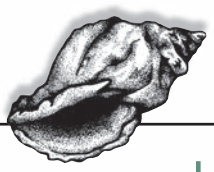
I am a **BALD EAGLE,** the boss of all the birds. Not only do I look great with my white head and tail, I also soar well and have a good voice that you can hear all over. I'm known for eating salmon, but I also like estuary birds. I'm not too good at catching healthy ones, but if there is a sick or wounded duck or brant goose, I'll find it. Some days, I just sit in a tree and hang out.

A **BARNACLE** may be common, but it's not boring! I stay closed inside my shell when the tide is low, but you should see me when the tide is high! I stick out my feathery feet and wave them through the water to catch plankton. My biggest enemy is the seastar, so it's wise for a baby barnacle to attach to a rock high enough to be out of the seastar's reach but low enough to get enough food.

How would you like to be a **SPONGE** like me? I'm a colony of lots of little animals living together. I sometimes grow attached to eelgrass, oysters, or other shells. I pump water in through lots of tiny holes, filter out the plankton for food, and then pump it back out through bigger holes at the ends of my "arms." Sea slugs like to eat me.

I'm a **HERMIT CRAB,** the most amusing critter around. I ramble around the tidepools, looking for fights, scrounging for food, poking in and out of my snail shell home. Like all crabs, I shed my own shell when I grow, but I also have to replace my snail shell now and then when I outgrow it. I'm useful as a scavenger, eating bits of plant and animal material and keeping the beach tidy.

I'm a half pint in the seastar world, a **SIX-RAYED STAR.** I only get to be about 2 or 3 inches across, so I'm easy to miss. I eat slow animals like snails, mussels, barnacles, and limpets. I'm greenish-grey, so I blend into the eelgrass and mud very well.



Is Dead Seaweed Garbage?

Follow these directions to find the answer...

1. A piece of dead sugar kelp seaweed gets washed up on shore. Is it garbage?
   __ Yes. Go to #12.
   __ No. Go to #9.

2. Wrong. Nutrients in the soil are used by plants.
   __ Now go to #11.

3. Right! Snails, worms, seagulls and other animals often eat dead things. Are there animals which eat live creatures?
   __ Yes. Go to #8.
   __ No. Go to #6.

4. Wrong. A rotting animal is food and a home for the living things which decompose it.
   __ Now go to #5.

5. Right. When bacteria and fungi "rot" things, they return them to the soil. The nutrients from their bodies become part of the soil. So this is where nature's garbage ends up finally, right?
   __ Yes. Go to #2.
   __ No. Go to #11.

6. Wrong. Animals like seals and great blue herons, for example, eat other animals.
   __ Now go to #8.

7. Wrong. Dead things in nature are never wasted. We call dead stuff *detritus,* and *detritus* is full of nutrients that can be reused again and again.
   __ Now go to #3.

8. Right! These animals are called predators. If an eagle eats a salmon and then flies away and dies and rots, is it garbage?
   __ Yes. Go to #4.
   __ No. Go to #5.

Is Dead Seaweed Garbage?

9. Right! Dead seaweed is alive with critters that eat it. Amphipods (or Beach Hoppers) are one example. What happens when these animals die? Are they garbage?

__ Yes. Go to #10.
__ No. Go to #13.

10. Wrong. There are so many amphipods that if no one ate them and decomposed their bodies, the beaches would be buried in their bodies!

__ Now go to #13.

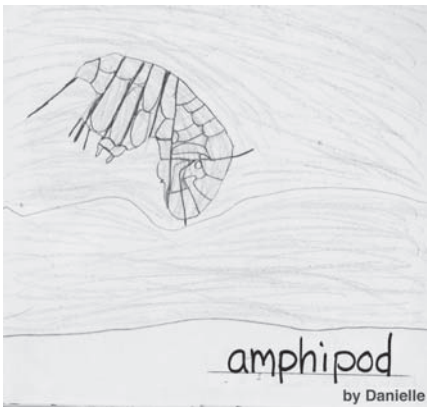
11. Right! Plants on the land will use these nutrients to grow. The rain will wash some of these nutrients back down to the estuary where they will nourish new seaweed to replace what died. And that brings us back to where we started . . . at #1. There is no garbage in nature, because everything is reused again and again in a circle.

12. Wrong. Dead seaweed is not worthless.

__ Now go to #9.

13. Right! Dead and living amphipods are food for birds like sandpipers. If a sandpiper eats an amphipod, but then the sandpiper dies, will its body be of any use?

__ Yes. Go to #3.
__ No. Go to #7.



From Marsh to Marina

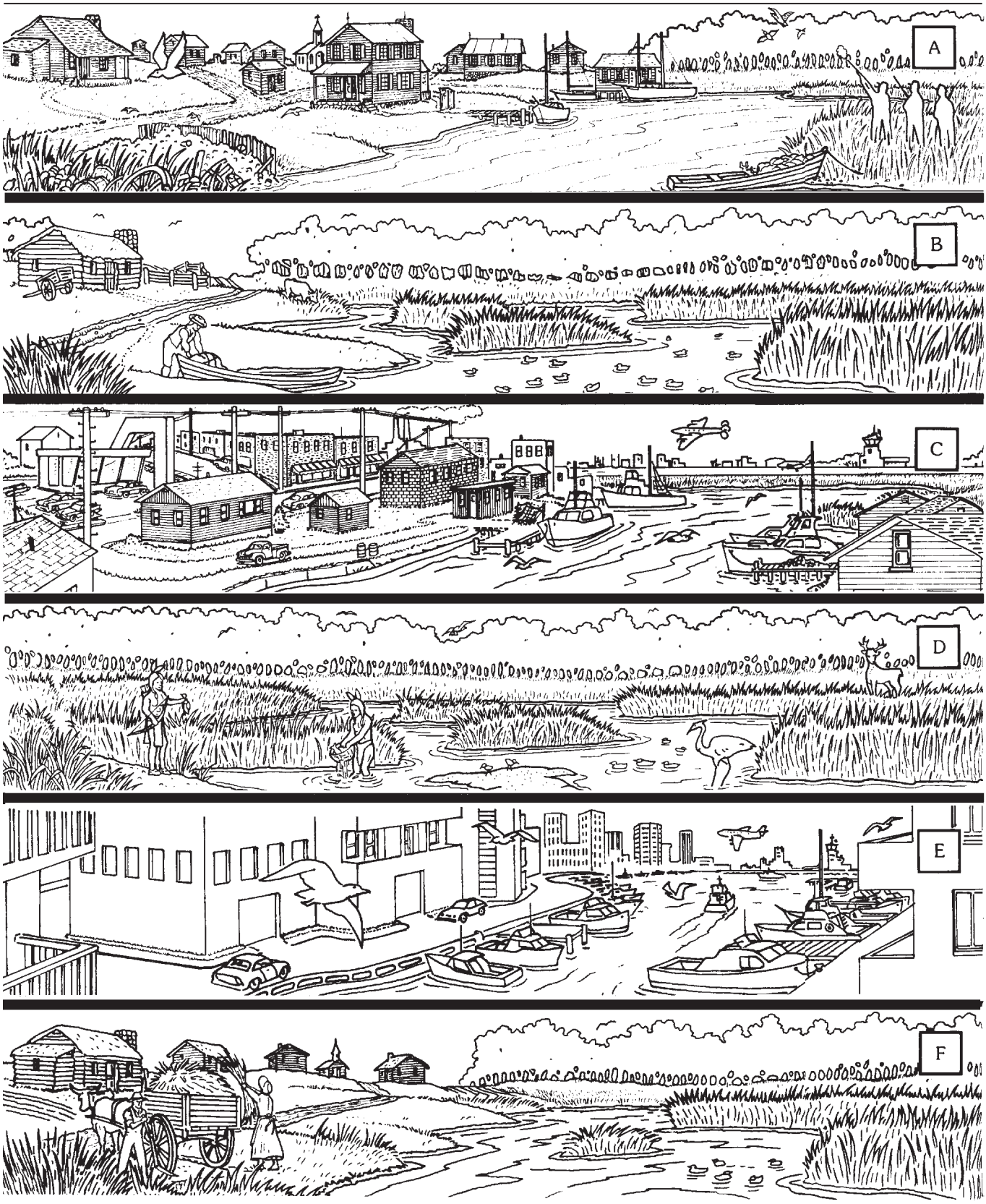
Estuaries and **Salt Marshes** can be great places to make a living. Native Americans living along the coasts knew this — and so did some of the earliest settlers. Try this activity to get your students thinking about how people have used (and abused) these wetlands over the years.

Begin by passing out the Marsh to Marina pictures on the next page. Explain that the pictures represent some of the ways people have used wetlands through time. Have the students cut out the pictures and then try to arrange them in order.

When everyone's finished, go over the answers. Then have each glue the pictures in the correct order on a large sheet of construction paper. (You might want to have the kids color the pictures). Have them label the time period of each picture as follows:

Picture D	before 1800
Picture B	mid 1800s
Picture F	late 1800s
Picture A	early 1900s
Picture C	1950s
Picture E	1990s

Afterward, hand out the information on page 60 to discuss each picture.


A
B
C
D
E
F

From Marsh To Marina

Picture 1: Native Americans were the first people to use the resources of salt marshes. Around the Skagit Valley the Salish people hunted and fished in salt marshes and estuaries. They found plenty of game in these wetlands — especially when huge flocks of ducks and geese passed through during migration. People gathered oysters, clams, and other shellfish in tidal creeks and mud flats. They built fish traps out of saplings and scooped the trapped salmon into cedar baskets.

Pictures 2 & 3: The first European settlers made their homes on the estuary shore during the 1800s. Living near the marsh wasn't an easy life. For one thing, clearing trees and stumps was hard work. Making the marshes into farmland meant building dikes and drainage ditches by hand with shovels and wheelbarrows. But there were advantages to the estuary, too. There was plenty of food, rich soil,and settlers used the waterways for transportation.

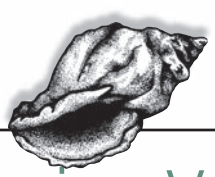
Picture 4: By the early 1900s, many estuaries in the Northwest had been settled. In some areas people began to have a big impact on the ecology of the land. Compare this picture with the first three pictures. Before there were so many people, the estuary could easily recover from the impact people had on it. But as the population grew, more serious and long-lasting changes were made.

Picture 5: By the 1950s, people had drastically changed many of the original estuaries. Many were filled in for houses, industries, and roads. Others were dredged for ships and marinas. Because there were no regulations protecting the water, pollution from towns and industries was a problem.

Picture 6: By the 1980s and 1990s, people passed laws protecting the water from pollution from factories and cities. Now one of the biggest threats to water quality is runoff from roads, farms, and neighborhoods. More people means more developed areas, more roads, and more houses. Animals like salmon have lost much of the estuary habitat they depend on.

Discuss:
List the ways people used the estuary. Describe a shoreline you know that may have been changed in this way. How did the way people value the estuary change over time? How are estuaries valuable to us today? Research your own estuary and create your own timeline.

This activity comes from Ranger Rick's NATURESCOPE,
a National Wildlife Federation publication,
Volume 2, Number 5, "Wading into Wetlands".

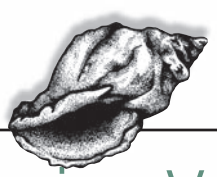


Changing Values

Read the following articles that show changing values of estuaries. Individually or as a class, answer these questions.

1. Look up the word "value" in the dictionary. Which definitions apply to the phrase "changing values of estuaries?"
2. What does each writer think estuaries or wetlands are good for? (How are they valuable?) Find words or phrases in each article that show the writer's attitude or values.
3. The 1961 editorial compares the developers who proposed an industrial site in Padilla Bay to the settlers who diked and drained the Skagit River estuary to create farmland. How were their values the same? How does the writer feel about people who were against the proposal?
4. In the 1989 editorial, the writer quotes President Bush as promising that no wetlands would be lost during his administration. The US Fish and Wildlife Service reports that 117,000 acres of wetlands were lost each year during that time. Discuss how that might have happened.
5. Think about this quote from the 1999 article from the Seattle Times. "We are going to be challenging an entire state about the way it behaves, and that's never been done before." What behavior do you think the speaker is referring to? How might that behavior be challenged?
6. Imagine how values might change in the next 15 years. Write the headline for an article about salmon, estuaries, or wetlands that may be published 15 years from now. (Or—write the whole article!)

Bonus - Collect newspaper articles about a current issue affecting your estuary.



Changing Values

Excerpts from an editorial in the Puget Sound Mail, La Conner, Washington. Thursday, November 23, 1961.

Proposed Padilla Bay Industrial Site Project Is Most Dynamic Reclamation Enterprise Since the Pioneers Diked and Drained the Skagit Delta Marshes

The proposed Padilla Bay industrial site project, in our opinion is the most dynamic reclamation proposal since the days when the farsighted and industrious pioneers diked and drained the marshes of the Skagit Delta to develop some of the finest farm lands in the nation. No doubt in pioneer times there were some who were against change and who thought it would be foolish to try and create farms out of the swampy wilderness and who felt the farms would ruin their hunting and trapping. But among the pioneers were "builders" of vision who strode forward to create. As the August edition of the Puget Sound Mail noted, it was a time when "Tall Men with tall ideas came to the Tall Tree country of the Skagit."

Even today there are some who are against change or betterment: some who "have it made" . . . But change and betterment will, and must come.

Here in Skagit County we have power, a great fresh water potential, and deep water near at hand - things of great importance to industry which can provide those needed year-around jobs. And this proposed reclamation of several thousand acres of tidelands for industrial site purposes would also help keep secure our valuable farmlands. In many states rich farmland has gone to industrial sites. In the Padilla Bay Project something new will be created instead of whittling away at the farmland...

This Padilla Bay Project could be one of the best such proposals in the state, or for that matter on the west coast. Opportunity is knocking at Skagit County's door and should not be ignored. We need more year around industrial employment to balance our economy—but we'll not get it without working for it . . .

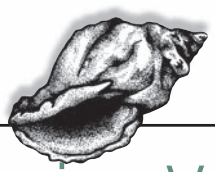
Padilla Bay, in Skagit County near Anacortes, offers the most favorable site for such an industrial development for the following reasons:

1. The bay is protected from storms by the surrounding islands.

2. Highway, railroad, power, water, natural gas and crude oil lines all pass close by the southern end of Padilla Bay.

3. Padilla Bay is an extinct delta of the Skagit River. This is a great advantage as the lands are completely stable with no active river to bring silts and form shoals in the dredged channels.

As one government man is reported to have stated when first viewing the proposed development: "Of all the proposed industrial areas in the U.S., this takes nothing from anything else—it creates something new, from tidelands."



Changing Values

An editorial from the Anacortes American, Anacortes, Washington.
Wednesday, July 26, 1989.

Bush, Rest of Nation Discover Wetlands are Worth Saving

They used to be considered useless land, suitable only for man to drain, fill and exploit.

We now call them wetlands, and a lot of people—from President Bush on down—think they must be saved. Bush has promised that not a single wetland will be lost during his administration. What a change from Ronald Reagan, who did not consider preservation of the environment to be a pressing matter.

Wetlands are saturated soil formations—bogs, swamps, marshes and the like. Man has been destroying them at an alarming rate. In a lengthy essay on the environment published this week, *Newsweek* magazine reported that about 500,000 acres of wetlands a year have been filled. A prominent regional example is the Snohomish River delta between Everett and Marysville, which has been filled in over the years for farms, sawmills and a freeway.

Why did this happen? Because previous generations believed wetlands were no big deal. And as far as visual appeal is concerned they still pale in comparison to virgin forests and wilderness areas. But as *Newsweek* points out, they are ecologically more significant than the national parks and wildlife preserves that attract far more attention.

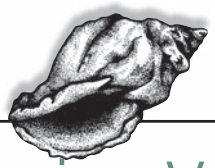
In fact, *Newsweek* lists saving the wetlands as one of five key environmental issues for the 1990s.

Folks on Fidalgo Island knew about the importance of wetlands long before *Newsweek* gave big play to the subject. The Evergreen Islands environmental-activist group has been taking a close look at wetlands in and around Anacortes. Local Audubon Society members are gearing up for an ambitious survey of all wetlands in Skagit County.

Why are wetlands important? Why should you care about an unattractive swamp? Because wetlands are prolific breeders of life ranging from the mundane (snails) to the spectacular (bald eagles). When we fill in and pave over a wetland, we snuff out a frighteningly wide range of life forms.

As *Newsweek* noted, wetlands have another important characteristic: they act as natural filters for removing pollutants from water. Man-made wetlands have been used to treat municipal sewage, and a citizens' group is lobbying for the wetlands-sewage approach instead of an expensive, federally mandated secondary sewer-treatment plant here. They're on to a good idea, but there's no hard evidence yet on whether their proposal would suit Anacortes. What's more, the city may not be able to escape from terms of the federal mandate, if town officials choose to do so.

The tools are in place to protect natural wetlands from develop-



Changing Values

ment, although the Environmental Protection Agency can and does make exceptions to the rules. It remains to be seen whether Bush's promise can be kept.

But at least our leaders now are talking about saving wetlands, not just about filling in swamps.

An excerpt from the *Seattle Times*, Seattle, Washington, March 14, 1999

Puget Sound Salmon on the Brink

Like it or not, the region is about to embark on a great debate about what the Northwest is to become. The Endangered Species Act listing of salmon will force us to choose between more for us and more for the fish.

"We've begun a historic debate, unlike anywhere else in the country, about the future of the region and its quality of life and natural resources," said Curt Smitch, the governor's special assistant for natural resources. "We are going to be challenging an entire state about the way it behaves, and that's never been done before. We don't know what the public is going to say.

"Maybe they don't want salmon. It's a fundamental policy debate based on values."

Some already think environmental regulations go too far. "We've lost all common sense," said Tom McCabe of the Building Industry Association in Olympia. "The salmon are being used to stop growth. We have a history in Washington of putting animals and trees ahead of people."

Exactly what it will take to bring back robust, fishable runs of wild Puget Sound chinook, the largest and most prized salmon, is far from clear.

Chinook have been in decline for decades. A generation of politicians and fish managers have made careers of salmon recovery.

Now, recovery of chinook in the Sound, if it occurs, will be a slow process of undoing the thinking, actions and investment that got us into this fix. According to fish managers:

A no-net-loss policy will be in effect with regard to salmon habitat. That means destroying fish habitat anywhere without making up for it will not be allowed.

Instead of building more dikes and jamming rivers into engineered, concrete channels, rivers will have to be reintroduced to their old flood plains, side channels and sloughs.

Fish need the quiet resting and feeding places that pools, meandering streams and side channels create. A straight, engineered chute of a river that rages during winter floods is a surefire salmon-killer.

Some dikes will have to come out. Some flood plains will have to be

Changing Values

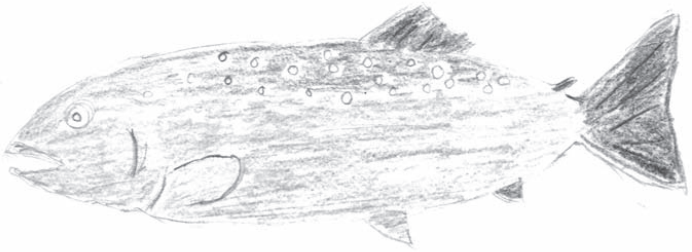
bought up and put in conservation so rivers can reclaim them. The natural volume of water will need to be restored in rivers where it has been sucked low for use by people.

"We have met the enemy and it is us," says Mike Schiewe, director of fish ecology at the federal fishery service's science center in Seattle.

We've logged the headwaters and banks of our rivers. Diked, dammed and channeled their flow. Drained, filled, and built on their flood plains. Polluted and developed their estuaries.

More than any single heroic rescue, restoring healthy runs of Puget Sound chinook will require a new philosophy toward the landscapes both we and these fish call home, said Bruce Sanford, who coordinates chinook programs for the state Department of Fish and Wildlife.

"It's about our priorities. Are salmon going to be part of our values, or aren't they?" Sanford asked. "Society needs to make a choice. We are trying to have it all and we can't."



salmon

by Daniel Van Norman

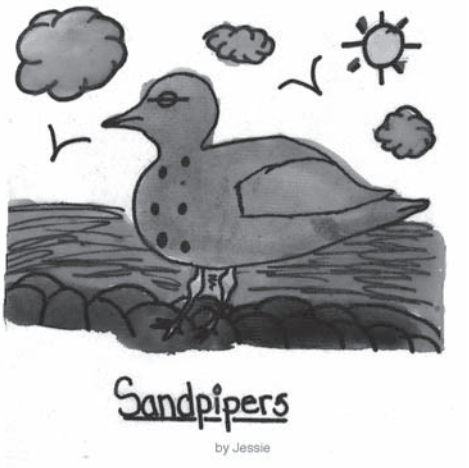
Making Good Decisions

This activity helps students examine connections between their own decisions or behaviors and the health of their estuary. Students create advertisements supporting thoughtful decisions in their watershed.

Individuals make decisions every day which may affect the health of their estuary. Some of the decisions are big, perhaps made by elected officials or government employees—decisions like how much discharge a city sewage treatment plant can release into the water. Most of the decisions, however, are small and personal—how we use water, how we care for our lawns, how much we drive our cars, or how we behave at the beach. Though the impact they have on the estuary may be small, our actions combine with the actions of thousands of other people to add up to something very significant.

1. As a class, brainstorm decisions students make that affect estuaries. Stress personal actions and choices, rather than group or societal choices. List the choices on the chalkboard, and discuss how they affect estuaries.

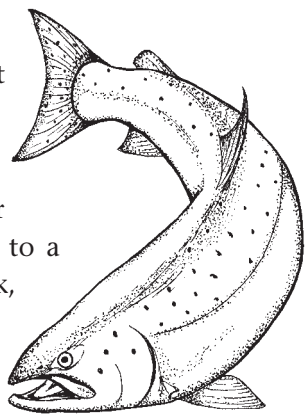
2. Divide the students into groups of three to five, and assign each group one decision from the list. Give them the task of "spreading the word" about their action. Students can make an advertising poster, TV commercial, radio announcement, etc., aimed at convincing others to make wise decisions. Use your imagination here—this can be a simple half hour task or a full blown multimedia production. Share your productions with the rest of the school—on a bulletin board in the hall, at an assembly, with fliers to take home, etc.



Watershed Salmbassador

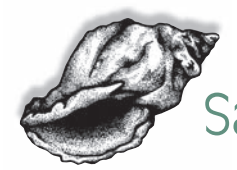
Use a stuffed salmon and a travel log to connect the schools in your watershed.

Salmon can't read street signs or find a school, but when they return from the ocean, they find their way back to the place they were born. By sending a salmon ambassador around your watershed, you and your students can share what you're doing to protect clean water and salmon, *and* learn how other schools in your watershed are doing the same.



1. Buy or make a stuffed salmon. Students can make one of fabric and fabric paints or of paper.
2. Name your salmon and create a travel log to document the trip. (See page 69 for ideas.)
3. Get a map of your watershed from the county or city and make a list of schools in your watershed. If your watershed is too large, consider limiting your project to a smaller area—perhaps the watershed of a stream or creek, or include only a sample of schools.
4. Mail a letter with your plan to all the schools that you hope to involve. (See sample on page 68.)
5. Send the salmon and travel log to the school at the bottom of the watershed (closest to the estuary) with instructions for using the travel log and sending it to the next school.
6. Set a timeline to insure your salmon returns before the school year is over. Include postcards addressed to your school to monitor the salmon's progress. (See sample on page 72.)
7. **Ask each school to pledge to help the salmon make it upstream by changing their own behaviors at home and at school.** (See *50 Simple Things Kids Can Do to Save the Earth* in reference section.)
8. When your salmbassador returns, celebrate with a Salmon Homecoming party. Share with the rest of the school.

On the following pages, you will find a sample letter to participating teachers, ideas for a travel log, a log template you may copy, and post cards for schools to mail back to you. Allow your students to create as many of the materials as possible.



Sample Salmbassador Letter

Dear Mr. Smith,

Our fifth grade class is tracking a salmon migrating through our ____ River watershed. The stuffed salmon, Sal, will be arriving at your school sometime around _____.

When she arrives, please follow the instructions for moving her along the way. As a class, please help the salmon fill in a section of the journal for your area of the watershed, If you'd like to include a picture of your class or artwork, that would be great!

We'd especially like to know what people are doing all over the watershed to protect salmon and their habitat. The pledge card is a chance for you to help out and to let us know what you are doing. Even a small promise like using less paper in your class or conserving water makes a difference.

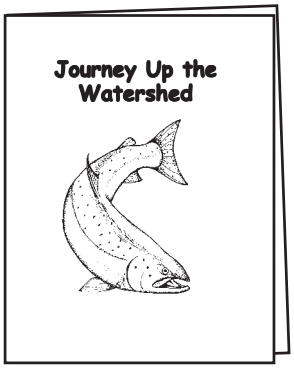
When you've added to the journal, please send us a postcard (included in the package) so we know where our salmon is travelling. Then send the salmon on to the next school on the list. We want our salmon to make it the whole way up the watershed from the estuary to the spawning grounds before school is out in June.

If there is no way your class can participate, please find another class in your school who can, or call us with questions. (Include phone number and address.)

Sincerely,

Ms. Jones' 5th grade class.

Salmbassador Travel Log Ideas



Your salmon's travel log will be a detailed record of what students are doing for salmon. Use the masters on the following pages, or customize your own. (Copy page 71 on both front and back for multiple pages—one for each school on your list.)

Here are some ideas for things to include in the log. You can choose those that will work for your class and watershed.

On the cover – Name your salmon; include a picture; make it a passport; use heavy paper or poster board; laminate it.

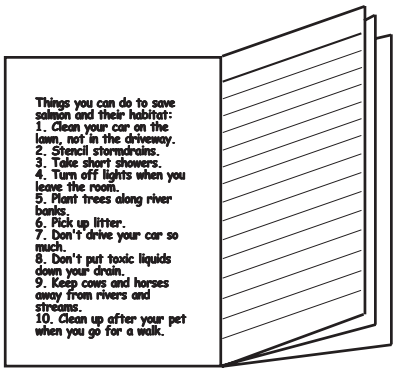
Inside the cover (front or back) – Include a map of the watershed or river. Ask schools to place their school on the map. Include a list of schools with their addresses, in their order in the watershed. Give information about the kinds of salmon using your river or stream and when they migrate.

Make a list of personal behaviors that help salmon and their habitat. (Conserve water. Conserve paper. Don't let toxic things like motor oil or paint thinner get down the drain or in the ditch. Plant trees along streams and rivers. Clean up after your pet. Pick up litter, carpool, take the bus, ride your bike, turn down your thermostat, and conserve electricity, etc.)

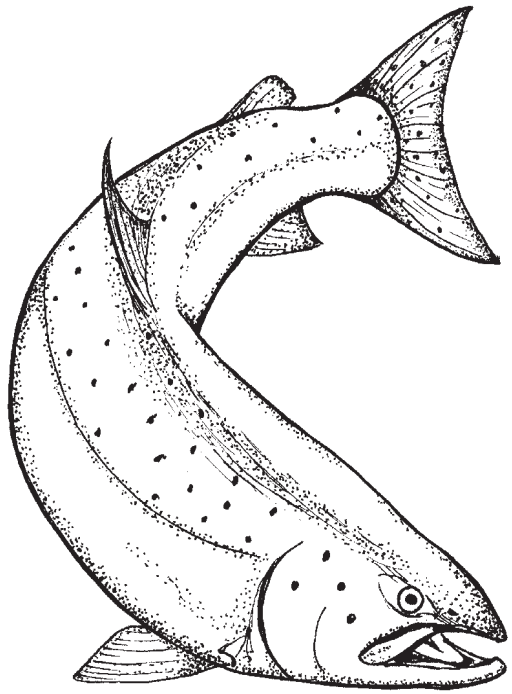
Entry pages – Leave room for artwork, make a place for photos, ask questions about participating schools, ask each school to add a piece of information about local salmon and their needs, make lined pages for a "notebook" look.

Include enough pages for all the schools to make entries. Don't forget to include your name and phone number in case teachers have questions.

Individual Journals – Make journals for each student in your class for observations, art, poetry, stories, etc.



Journey Up the Watershed



We pledge to help salmon make it through our watershed.
This is what we will do:

I arrived at _____ school on _____

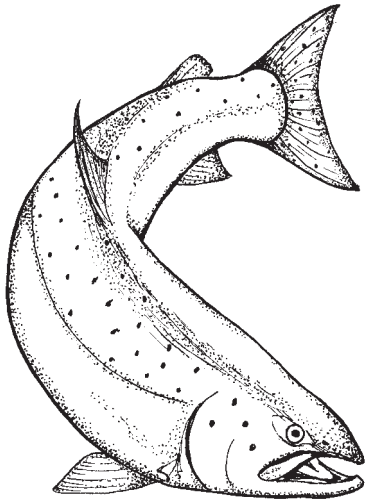
The water from the school parking lot goes to this stream or river:

The river or stream near here looks like:

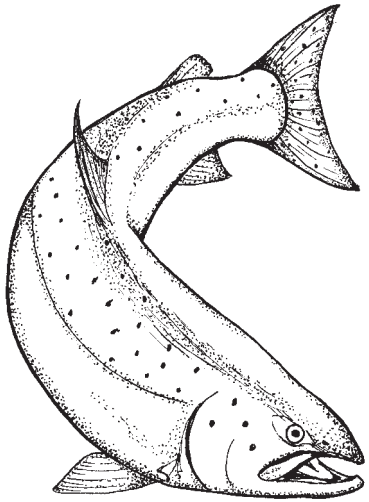
The land around the stream or river looks like:

These kinds of salmon use the stream or river:

These are things people are doing to make my habitat better:



I'm on my Way!



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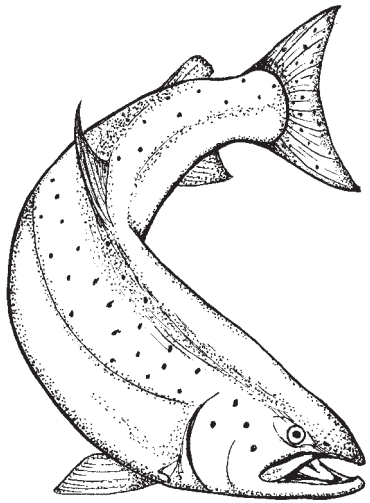

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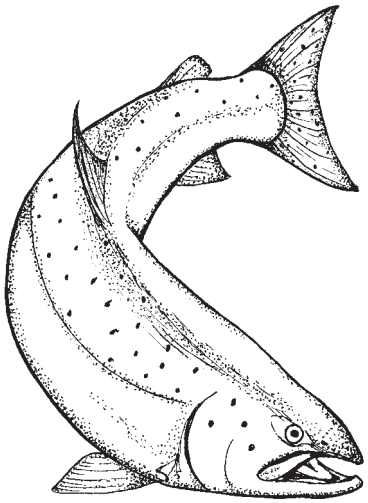

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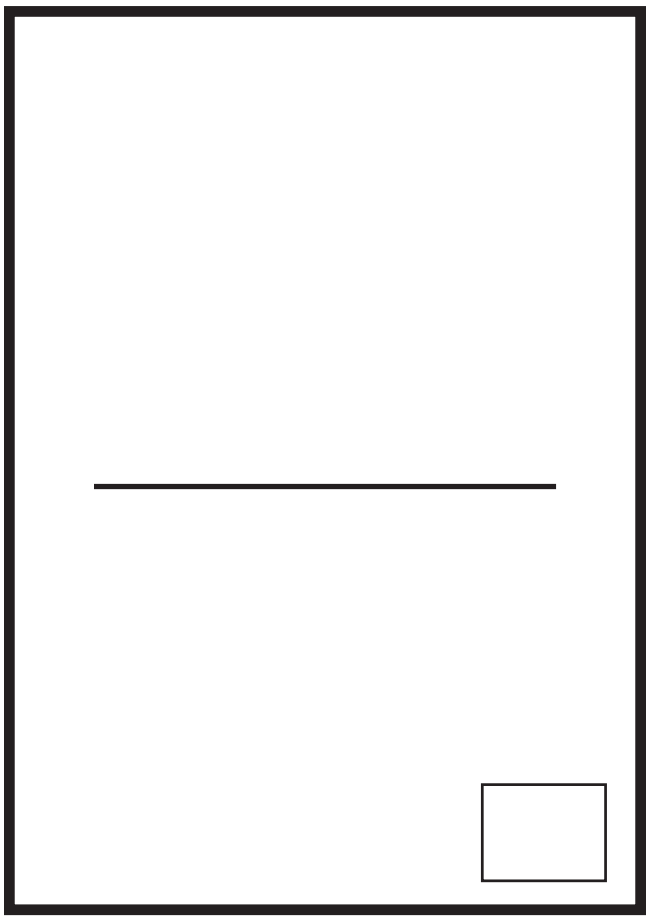
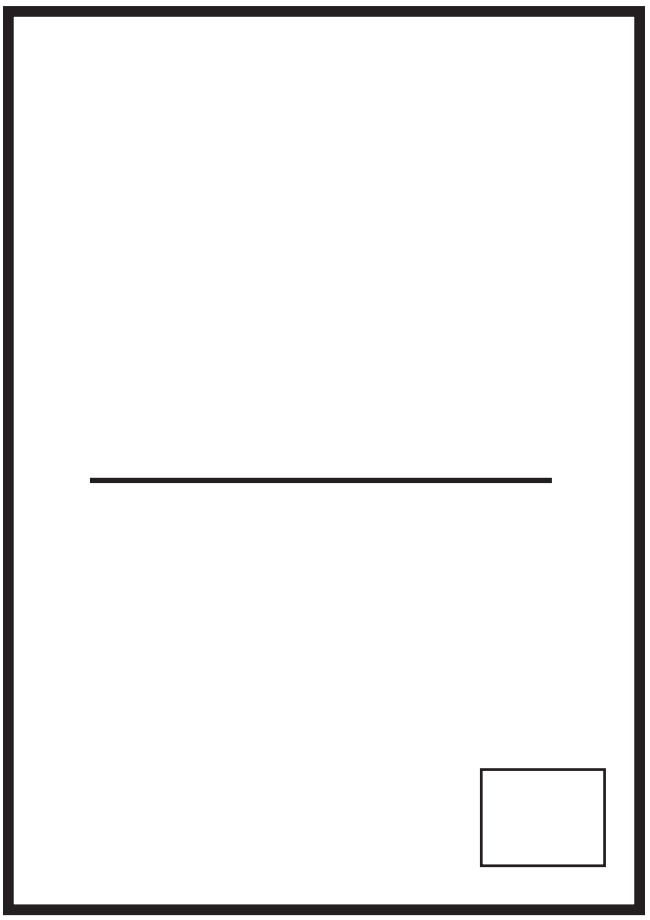
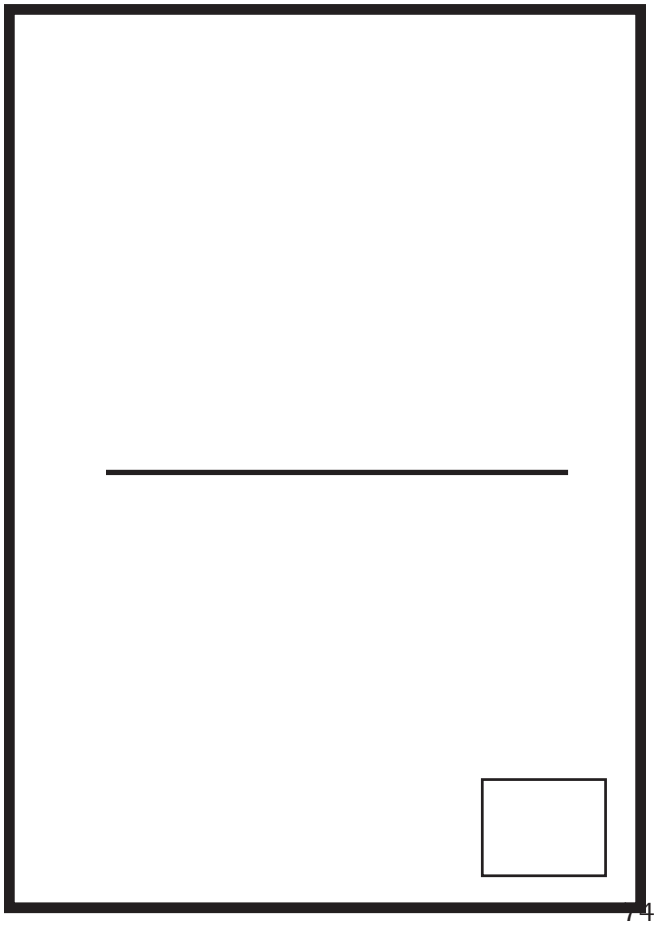
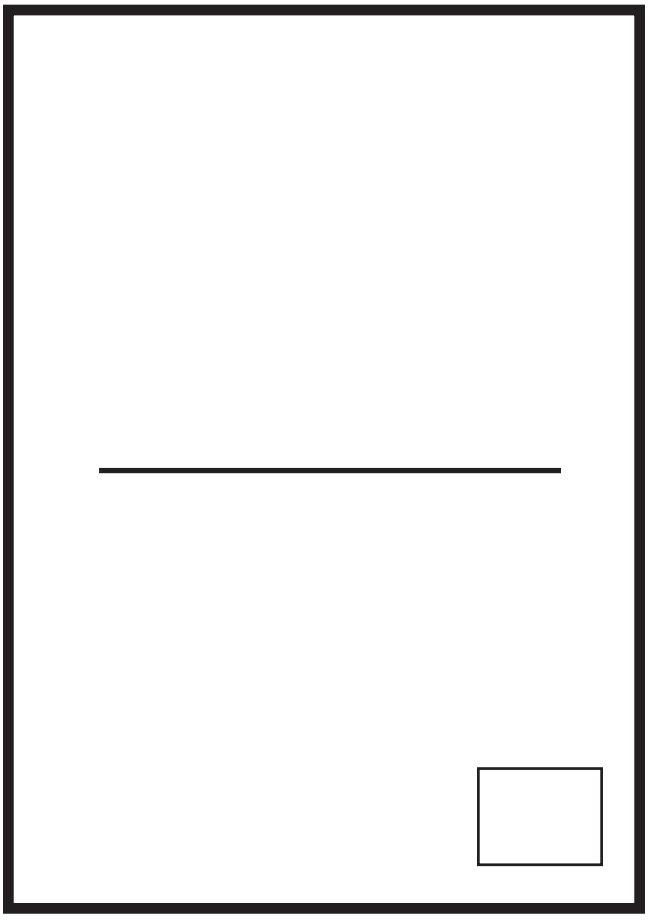








Drawing Your Own Water

Research and draw your place in the water cycle.

You've probably learned about the water cycle. Water evaporates from the ocean. Clouds form. Rain falls . . . But did you ever think of yourself as a part of that cycle?

Think about the water that goes through ***your*** house. Where does it come from? Where does it go? Do you live near a river or stream? Do trees in your yard take water from the soil and evaporate it through their leaves?

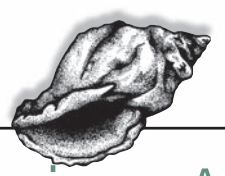
Research your water cycle. Find out exactly where your water comes from (a well? a water treatment plant?). If it comes from a river, where does the river start? Where does it end up after it goes down the drain? Does it end up in an estuary?

Using this information, draw a picture of ***your*** water cycle. From this list, use any labels that apply to your water:

condensation
evaporation
lake
stream (name?)
river (name?)
estuary
ocean (name?)
water tower
evapotranspiration
water treatment plant
sewage treatment plant
wastewater outfall
drain pipe
septic tank
drain field
ground water
wetland
well
cloud
sewer pipe
your home
tree

1. Make a list of things that might go down the drain with the water at your house or school.

2. Choose 2 items from your list. Call 1-800-RECYCLE and find out if those are OK to have in the water cycle. Can they be cleaned up at the sewage treatment plant or in a septic tank? If they are harmful to the environment, are there safer alternatives?



Getting Serious About Cars

Think about how cars contribute to water pollution, and survey your school vehicle use.

Cars! What could be more important to us? You may have heard that automobiles are the largest source of air pollution in Washington, but have you ever thought of cars as water polluters, too?

What goes up usually comes down. Invisibly, air pollution clings to water in the clouds and comes down as polluted rain. A car's tires wear on the road and leave cadmium and zinc to be picked up by the next rain. A parked car drips oil and grease. Chromium and zinc wear off the body. Copper and lead come from the engine. Once on the driveway or road, this ends up in ditches, storm sewers, and eventually the estuary. As much as we might hate to admit it, driving less is good for the estuary.

Here are four short surveys which look at how we get around. You may want to divide into four small groups and do one survey each.

1. The Buses

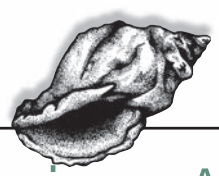
Interview bus drivers. Ask them the number of miles they drive each day for your school. Find out their gas mileage and the average number of students per trip.

Calculate the total amount of gas used by buses to bring students to your school each day. Calculate the amount of gas used per student per day.

2. Parent Drivers

Count the number of students who get a ride to or from school from a parent or friend. (You may need to plan a "stake out" where students are dropped off, getting adult help for safety.) Find out: how far they drive, how many students ride in each car, what the gas mileage is, and why they didn't use the bus.

Calculate the total amount of gas used by students who get a ride to school. Calculate the amount of gas per student per day.



Getting Serious About Cars

3. The Faculty Parking Lot

Design a survey to find out what percentage of teachers drive to school. In your interview, find out if public transportation is available. If available, why don't the teachers take the bus? Ask if they ever car pool and why. Find out how many miles they commute daily. What is their gas mileage? Calculate how much gas is used per teacher per day driving to school. Calculate the total amount of gas used by teachers each day.

4. The Pavement

Estimate the percentage of your school property that is paved for vehicles.

Go outside and find a storm drain or ditch that catches runoff from the parking lot. (This is easy if it's raining.) Make a note of any visible pollutants on the pavement or in the water. Where does the water go from there? If you need to ask your local public works department for information, designate one person to call.

Sharing your results with the rest of the class, work together to answer these questions.

1. Why do some teachers and students choose not to use the bus? What difference would it make if they did?

2. How much space in your community is set aside for the care and use of cars? (Consider driveways, garages, streets, gas stations, freeways, malls. Look in the yellow pages in the automobile section for more ideas.) How does this compare to the amount of space set aside for people to live, play?

3. Does the runoff from your school parking lot go directly to a body of water, or is it treated first? If it goes to a sewage treatment plant, are toxins removed from the water there?

4. List 10 advantages and 10 disadvantages for driving a car. Rank them. When do **you** choose to not use a car?

Perusing the Poisons

Check your homes for common toxic substances and learn about their proper disposal and safer alternatives.

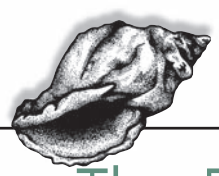
Many useful products around our homes are hazardous to people, animals and the environment. If we pour these products down the drain, in a ditch, or in the backyard, there is no doubt they will contact living organisms. Eventually they may drain into a wetland, the groundwater, or an estuary where they can cause trouble.

You **must** ask a parent or adult to assist you with this inventory! Hunt around your house, basement, and garage to find out which of these products you have. Note whether it will be used again. Think of ways it might get into the water. Then check the labels. "Caution," Warning," and "Danger" all mean the product is toxic, with caution being least harmful and danger being most harmful.

Caution: Please be very careful handling these products. While not all household products are hazardous, many could be harmful. Do not open any containers, and wash your hands carefully after handling.

With your class, discuss ways to properly dispose of toxic substances. If you have questions, call 1-800-RECYCLE to find out what to do with toxic waste from you home.

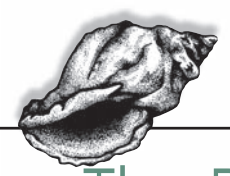
Do you have?	Will it be used?	How could it get into water?	Caution, Warning, or Danger	Safer Alternative
PAINTS __Enamel or oil based paints				
__Latex or water based paints				
__Rust paint				
__Thinners and turpentine				
__Furniture stripper				
__Stain or finish				



Perusing The Poisons

Household products inventory

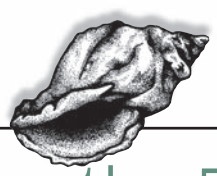
Do you have?	Will it be used?	How could it get into water?	Caution, Warning, or Danger	Safer Alternative
HOUSE __Oven cleaner				
__Drain cleaner				
__ Toilet cleaner				
__Disinfectants				
__Upholstery or rug cleaners				
__Furniture or floor cleaners				
__Cleaners with bleach				
__Photographic chemicals				
__Silver polish				
__Pool chemicals				
__Cleaners with ammonia				
__Spot removers				
__Abrasive cleaners				



Perusing The Poisons

Household products inventory

Do you have?	Will it be used?	How could it get into water?	Caution, Warning, or Danger	Safer Alternative
AUTO __Antifreeze				
__Used oil				
__Brake fluid				
__Transmission fluid				
__Batteries				
__Gasoline				
PESTICIDES __Herbicides				
__Mouse and rat killer				
__Roach and ant killer				
__Flea collars and sprays				
__Insecticides				
__Fungicides				
__Slug bait				
__Mothballs				
OTHER __				

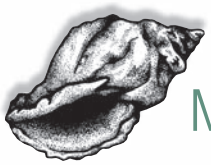


Perusing the Poisons

Potentially Hazardous Household Products - Some Safer Subs

For this product	Try this safer substitute
Air freshener	Cinnamon & cloves (simmered)
Bathtub and tile cleaner	Baking soda & vinegar & water
Burn mark remover	Grated onion
Coffee cup stain cleaner	Salt (moist)
Decal remover	Vinegar (soak in white vinegar)
Drain cleaner	Plunger; baking soda or vinegar & hot water
Furniture polish	Olive oil; lemon juice & mineral oil
General household cleaner	Baking soda
Hand cleaner for paint/grease	Baby oil
Ink spot remover	Cream of tartar & lemon juice & cold water
Insects on plants	Soap & water
Moth repellent	Proper storage & laundering of clothing
Oil based paint	Water based paint
Oil stain remover	White chalk (rubbed in before laundering)
Paint brush softener	Vinegar (hot)
Refrigerator deodorizer	Baking soda
Roach repellent	Roach trap or "hotel"
Rug cleaner	Club soda
Rust remover	Lemon juice & salt & sunlight
Shoe polish	Banana peel
Slug repellent	Diatomaceous earth, copper flashing
Spot remover	Club soda; lemon juice; salt
Water mark remover	Toothpaste
Window cleaner	Vinegar (in warm water)
Wine stain remover	Salt

Adapted from *Away with Waste*
Washington State Department of Ecology Publication #98-200, 1998.



More Ideas

Language Arts

- Describe a day in the life of a young salmon who has journeyed downstream to the estuary. What kinds of plants and animals do you see? Where do you like to hide? What do you eat? What are you afraid of? How is life different here than it was upriver? What will it be like in the ocean?
- Write a letter to the Padilla Bay educators about your field trip. Include information about what you learned there and actions you could take to keep your own estuary healthy.
- Write poetry, haiku, or other forms of expression on an estuary theme.
- Make up riddles or limericks about estuaries or estuary animals. Have others guess your subject.
- For each letter in ESTUARY, have the children write a word or phrase describing an estuary.
- Play password with the new estuary vocabulary words.

Social Studies

- Research the role of salmon in Pacific NW culture over the last 250 years.
- Describe the life of a Native American child living by Padilla Bay 200 years ago.
- As an early explorer, write a letter back to Europe explaining why Padilla Bay would or would not be a good place to settle.
- Interview older local folks for memories of “before."
- Write laws relating to the use and protection of estuaries and vote on them.
- Invite your local or state representative to speak to your class on an issue affecting your estuary.
- Look at maps of the country and world. Locate major rivers and their estuaries. How many cities can you find that are built on estuaries? Prepare individual reports on different estuaries around the world.
- Set up a debate between two groups with opposing viewpoints on a local land use issue.

More Ideas

Math

- Estimate the number of plankton in Padilla Bay. Count the number of plankton in a small sample of water from the bay. Then, estimate the volume of water in the bay. (The average depth of Padilla Bay at high tide is 8 feet and the bay covers about 6,630 hectares.)

Science

- Learn the taxonomic classification system for marine organisms.
- Make and use a dichotomous key for shells.
- Write a research proposal about one specific thing you'd like to know more about from your trip to Padilla Bay. Include a research question, hypothesis, proposed methods. Be sure to consider logistics (cost, materials, time, tides, etc.).

Creative Dramatics

- Play charades. Act out how animals move and eat.
- Demonstrate a "food chain in action" as a group effort (seastar eating a clam, heron spearing a fish, a large anemone filter feeding, etc.).
- Tell a story about the estuary without words.
- Have one student be the sun and ask each in turn to add a link to the food chain.

Creative Thinking

- Design mud shoes. (Think of snow shoes.)
- Study why animals become endangered and what, if anything, we should do about it.
- Create a mythical estuary in another world. Use what you know about your estuary, and transfer that to your new world. Think about how energy moves through food chains. (Who are your producers or carnivores?) Are there tides? (What if your world has 4 moons?) How are organisms specially adapted to your environment? What great interconnections can you think up? Are there people near your estuary?

More Ideas

Art

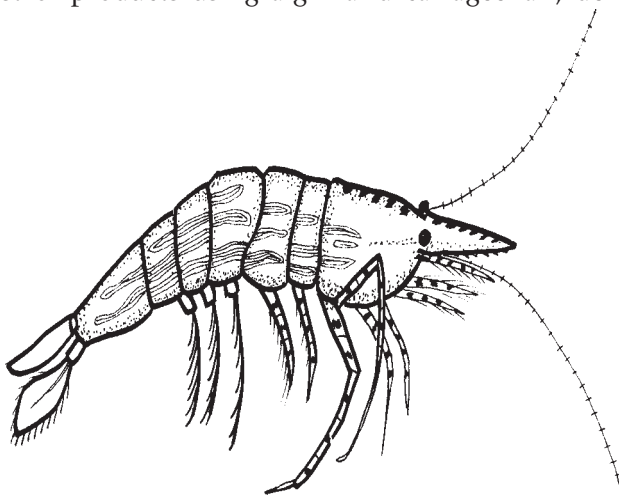
- Draw a mural of a beach scene and have each student add to it, filling in the picture.
- Try Gyotaku, fish printing. Compare a flounder to a salmon.
- Make clam shell rubbings and note differences in shells.
- Use the shapes of plankton as part of a painting.
- Make plaster castings of shells.
- Create a photo essay of a day in an estuary.
- Draw a comic strip about a hermit crab.

Music

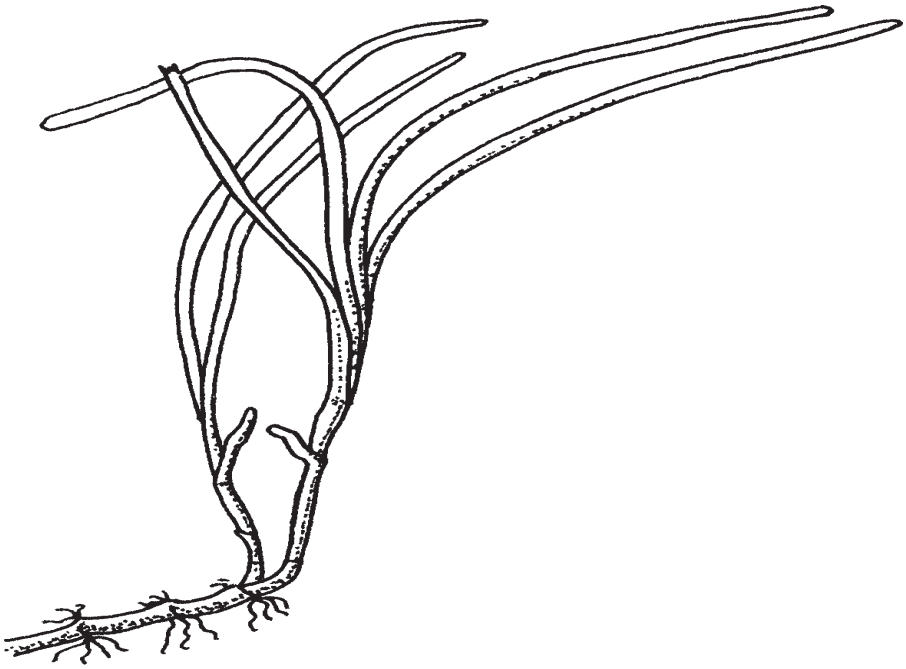
- Make a sound collage of an estuary.
- Try to imitate bird songs, animal calls. Tape yourself.
- Make a reed flute, clamshell chimes.
- Play music that reminds you of water. (*The Moldau* by Smetana, *LaMer* by Debussey)
- Sing sea chanties.

Health

- Prepare a menu for breakfast, lunch and dinner using food from the estuary—a seafood feast!
- Make a list of products using algin and carrageenan, derivatives of algae.



Resources



Resources

Children's Books

Cherry, Lynne, *A River Ran Wild*, New York: Harcourt Brace & Company, 1992.

Cone, Molly, *Come Back Salmon*, Hong Kong: Sierra Club Books, 1991.

Cole, Joanna, *The Magic School Bus at the Water Works*, New York: Scholastic Inc., 1986.

Cole, Joanna, *The Magic School Bus on the Ocean Floor*, New York: Scholastic Inc., 1992.

Earthwork Group, *50 Simple Things Kids Can Do To Save the Earth,* Kansas City: Andrews & McMeel, 1990.

Hirschi, Ron, *People of Salmon and Cedar*, New York: Cobblehill Books, 1996.

Holling, H. Clancy, *Pagoo*, Boston: Houghton Mifflin Co., 1969.

Lewis, Barbara A., *The Kid's Guide to Social Action*, Minneapolis: Free Spirit Press, 1991.

Magazines

Clearing: Nature and Learning in the Pacific Northwest
Environmental Education Project
P.O. Box 751
Portland, OR 97207
A valuable network of people and places, information on "happenings," ideas, activities, and resources for teaching about the environment.

Ranger Rick
National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington, D.C. 20036-3366
Outstanding children's magazine packed with incredible photography and age appropriate information.

Resources

Reference Books

Berrill, J.J. and Jacquelyn, *1001 Questions Answered About the Seashore*, New York: Dover Publications, 1957.

Coulombe, Deborah, *The Seaside Naturalist*, New Jersey: Prentice-Hall, Inc., 1984.

Flora, Charles and Eugene Fairbanks, M.D., *The Sound and the Sea*, Bellingham, WA: Western Washington Press, 1982.

Kozloff, Eugene, *Seashore Life of the Northern Pacific Coast*, Seattle, WA: University of Washington Press, 1983.

Snively, Gloria, *Exploring the Seashore of British Columbia, Washington and Oregon*, Vancouver, B.C.: Gordon Soules Book Publishers Ltd., 1978.

Yates, Steve, *Marine Wildlife of Puget Sound, the San Juans, and the Strait of Georgia*, Connecticut: The Globe Pequot Press, 1988.

Zim, Herbert and Lester Ingle, *Seashores: A Guide to Animals and Plants Along the Beaches*, New York: Golden Guide Press, 1955.

Curricula

Alaska Sea Week Curriculum Series
Alaska Sea Grant College Program
University of Alaska
Fairbanks, AK 90701
A wonderful series of interdisciplinary beach and classroom activities in all aspects of marine studies, for elementary grades; award winner.

Aquatic Project Wild
Project Wild Coordinator
Washington State Department of Fish and Wildlife
600 Capital Way North
Olympia, WA 98501-1091
(360) 902-2200
A compilation of diverse, interdisciplinary activities for all ages. Available through teacher workshops only.

Resources

Beach Explorations
Sea Grant Marine Education
Hatfield Marine Science Center
2030 Marine Science Drive
Newport, OR 97365
Written by Gloria Snively, this guide for teachers of grades 5 to 10 includes extensive background information about northwest beach life as well as field trip and classroom activities.

Coastal Zone Studies
Washington State Office of Environmental Education
17011 Meridian Avenue North #16
Seattle, WA 98133-5531
In-depth junior and senior high school curriculum for studying coastal areas, including estuaries.

Discover Wetlands
Washington State Department of Ecology
PO Box 47600
Olympia, WA 98504-7600
A collection of information and activities focusing on wetlands in Washington State for grades 4 to 8.

The Estuary Book and others
Western Education Development Group
University of British Columbia
Vancouver, B.C. CANADA V6T 1W5
This is one of a series of booklets on various water habitats, with information and activitie for middle school and older.

The Estuary Study Program
South Slough National Estuarine Research Reserve
P.O. Box 5417
Charleston, OR 97402
An imaginative on-site program for upper elementary and junior high school plus classroom activities for senior high.

Hanging on to Wetlands
Irwin Slesnick
Biology Department
Western Washington University
Bellingham, WA 98225
Interdisciplinary classroom and field activities for studying wetlands.

Resources

Naturescope
National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington, D.C. 20036-3366
A creative education series introducing children to the natural world. Sixteen books cover such topics as oceans, wetlands, mammals, birds, and endangered species.

OBIS: Outdoor Biology Instructional Strategies
Delta Education, Inc.
Box M
Nashua, NH 03061-6012
Creative and active ideas in environmental education, marine studies included; for all ages.

ORCA: Ocean Related Curriculum Activities
Marine Education Project
Pacific Science Center
200 Second Avenue North
Seattle, WA 98109
(206) 443-2001
Interdisciplinary curriculum for grades 1 to high school with topics including salmon, tides, beaches, oceanography, marine biology, and early fishing peoples of Puget Sound.

Project for Sea
Marine Science Center
17771 Fjord Drive N.E.
Poulsbo, WA 98370
Extensive and exemplary curriculum for all grade levels; content includes animal and plant identification and ecological concepts; award winner.

Project WET
Rhonda Hunter, Project Wet Coordinator
Washington State Department of Ecology
PO Box 47600
Olympia, WA 98504-7600
(360) 407-6145
An interdisciplinary water education program promoting awareness, appreciation, knowledge and stewardship of water resources. Available through teacher workshops. K-12

Resources

The Seattle Aquarium Curriculum
The Seattle Aquarium
Pier 59, Waterfront Park
Seattle, WA 98101
Curriculum for all grades to supplement visits to the Aquarium; teacher information, pre- and post-visit activities included.

WOW!: The Wonders of Wetlands
Environmental Concern Inc.
PO BOX P
St. Michaels, MD 21663
Comprehensive classroom and outdoor wetland activity for grades K to 12.

Places

Bellingham Maritime Heritage Center
1600 "C" Street
Bellingham, WA 98225
(360)676-6806

Discovery Park
3801 West Government Way
Seattle, WA 98199
(206)386-4236

Marine Life Center
1801 Roeder Ave.
Bellingham, WA 98226
(360)671-2431

Port Townsend Marine Science Center
Fort Worden State Park
Port Townsend, WA 98368
(360)385-5582

Poulsbo Marine Science Center
17771 Fjord Drive N.E.
Poulsbo, WA 98370
(360)779-5549

The Seattle Aquarium
Pier 59, Waterfront Park
Seattle, WA 98101
(206)386-4300

Everything in nature changes; this program, too, is evolving. We are always in need of, and grateful for your ideas and constructive feedback. Please feel free to send us your thoughts and suggestions about this curriculum and your experience at Padilla Bay.

Thank you so much!