

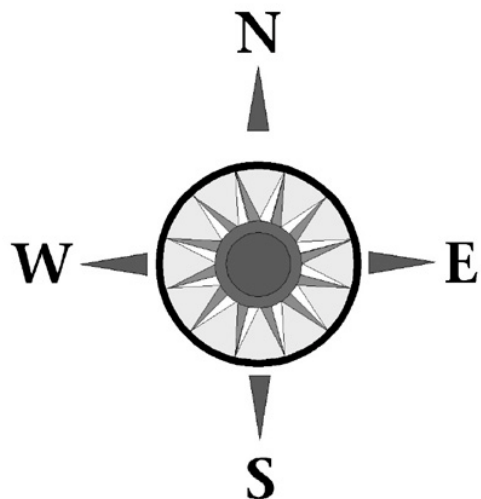
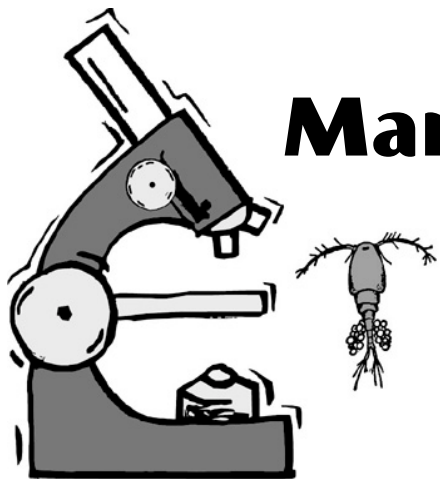


Teacher Packet

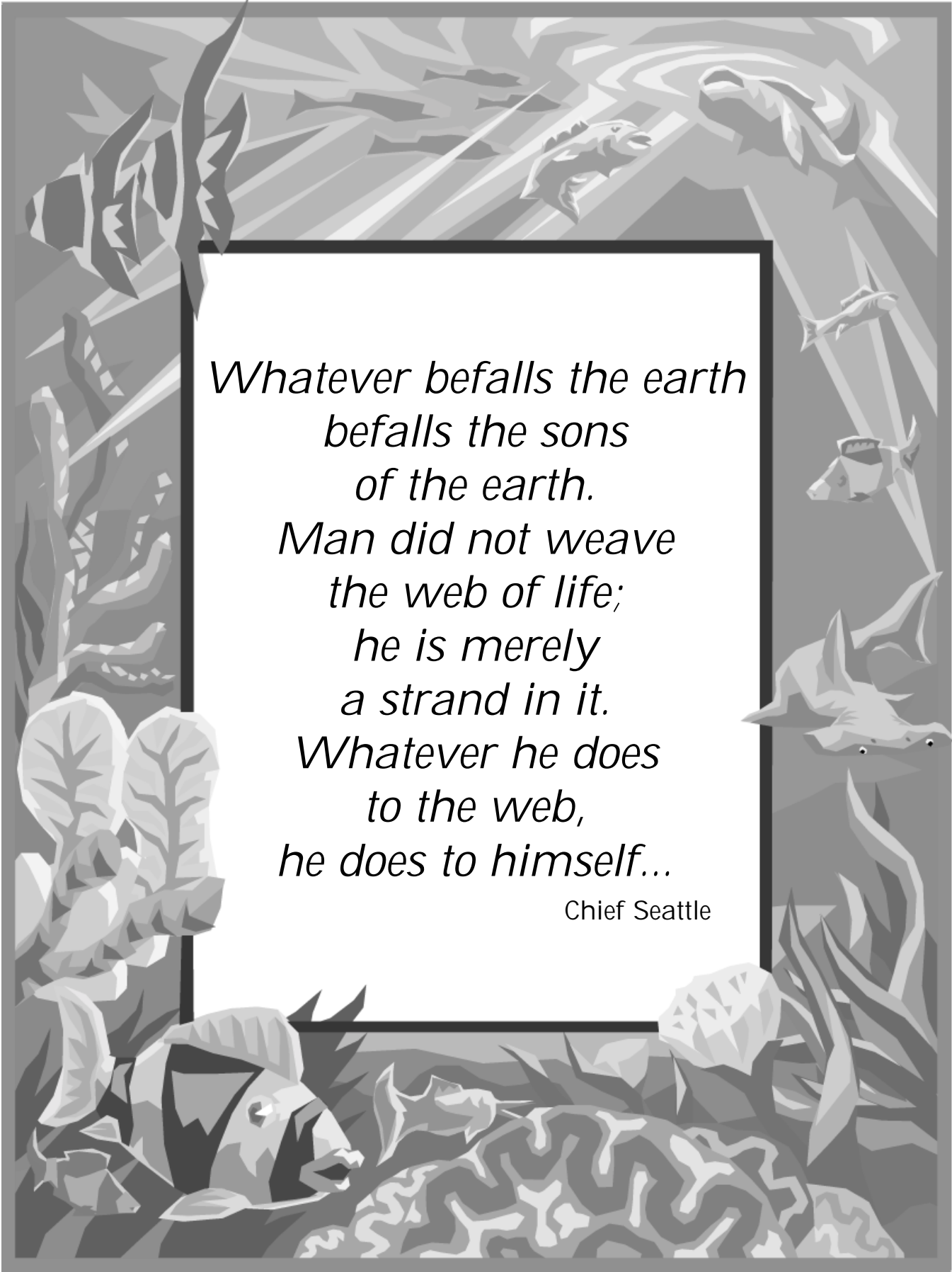
Marine Ecology



Marine Biology



Navigation



*Whatever befalls the earth
befalls the sons
of the earth.
Man did not weave
the web of life;
he is merely
a strand in it.
Whatever he does
to the web,
he does to himself...*

Chief Seattle

Introduction

The O'Neill Sea Odyssey teacher's packet is a collection of curriculum materials designed to help teachers prepare their students for our three-hour environmental education program. The staff and crew at O'Neill Sea Odyssey has found over the years that students who have been given an overview of our subjects before participating in the program benefit from a more in depth educational experience.

Understanding that many teachers have already established a curriculum for the school year, this packet is designed to allow teachers to expose their students to environmental and oceanographic concepts with a minimal time commitment. If time is an issue we recommend focusing on the glossary for each section of the packet paired with one glossary oriented exercise such as:

- *Marine Biology Glossary of Terms (page 7)*
- *Plankton Puzzle (page 14)*
- *Ecology Expertise (page 19)*
- *Ecology Word Search (page 21)*
- *Nautical Know-How - Glossary of Basic Terms (page 28)*
- *Nautical Know-How Puzzle (page 30)*

More intensive study can be a useful follow up to your participation in our program.

The staff and crew of O'Neill Sea Odyssey would like to take this opportunity to thank our participating teachers and group leaders for all of their hard work in preparing their students for our program. We look forward to seeing you aboard the Team O'Neill.

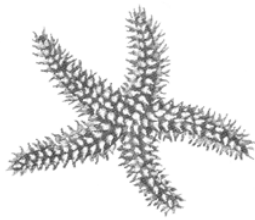
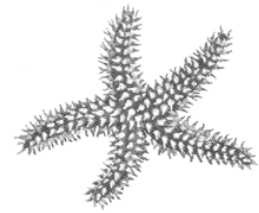
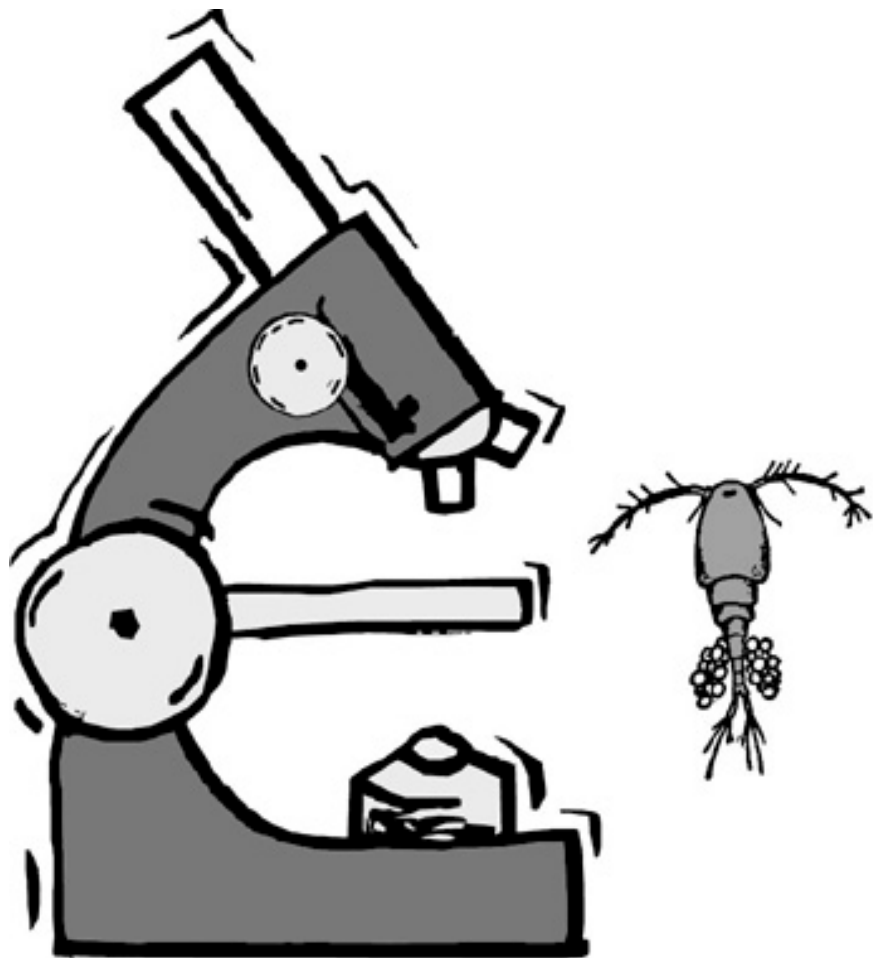


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Marine Biology





MARINE BIOLOGY

BACKGROUND INFORMATION

- There are less than 100 species of plants in the ocean compared to some 250,000 flowering plants on land.
- Ocean plants can be found in the upper 100 feet (30m) where they can get light and energy from the sun's rays.
- Because they live in the dense environment of water, ocean plants do not need roots to anchor themselves against the force of gravity. Instead, they drift along at the mercy of the ocean currents.
- More than 99 percent of all plant life in the sea consists of a floating layer of microscopic particles called plankton. Although most cannot be seen with the naked eye, plankton are there by the millions taking up nutrient salts and minerals directly from the sea water surrounding them.
- With the right environment – increasing hours of sunlight and ocean waters stirred by winter storms – they may double their numbers within two days.
- All animals must eat, and all are potential food for other animals. Plants and animals are connected to each other in predator-prey relationships called food chains and food webs.
- The marine food chain is similar to a pyramid. The largest creatures at the top could not exist without the layers of increasingly smaller animals below it.
- Tiny animals eat microscopic plant life and use the nutrients for their own growth. These small animals become food for larger animals. As one animal eats another these nutrients are passed along to each animal.

MARINE BIOLOGY BASICS

GLOSSARY OF TERMS

BLOOM – A sudden increase in the number of phytoplankton often following a flood of nutrients from heavy rain or a string of sunny days

CLARITY – Measurement of the amount of solids suspended in a liquid; how clear or cloudy a liquid is

CHLOROPHYLL – The pigment used in photosynthesis to capture light energy and convert it to chemical energy

CONSUMER – An animal that eats producers or eats other animals that eat producers

COPEPOD – An important, abundant zooplankton; tiny crustacean

CRUSTACEAN – Animals with a tough exoskeleton, jointed appendages & many legs (such as crabs)

DEPTH FINDER – An instrument used to measure the depth of water, especially by radar or ultrasound

DECOMPOSER – Organisms such as fungi and bacteria that break down living or dead material into chemicals that can be recycled as nutrients

DIATOM – Phytoplankton with a glass-like shell made of silica

DINOFLAGELLATE – Phytoplankton often with two whip-like flagella; sometimes poisonous

ENERGY FLOW – The movement of energy from the sun through living organisms in a food web

FLAGELLA – Whip-like extensions of a cell; used in locomotion

FOOD CHAIN – A transfer of food energy from one organism to another

KRILL – A two inch long marine crustacean that grows in abundance; an important source of food for some baleen whales

LARVAE – The immature juvenile form of an animal

MICROSCOPE – An instrument used to magnify the size of an object for study purposes

NUTRIENTS – Chemicals required for organisms to live and grow (example: phytoplankton requires nitrogen and phosphorus)

PHOTOSYNTHESIS – Process in which light energy is converted to chemical energy by plants using water, carbon dioxide; results in the production of oxygen & carbohydrates such as sugar & starches

PHYTOPLANKTON – Plant plankton

PLANKTON – Aquatic organisms that drift with the current or have limited swimming abilities

PLANKTON NET – A net used by marine biologists for collecting plankton

PRODUCER – Organisms that convert light energy to chemical energy (phytoplankton, plants)

RED TIDE – Bloom of phytoplankton, usually dinoflagellates

SALINITY – The degree of saltiness of a given substance such as the ocean

SECCHI DISK – A circular plate, about 10 to 12 inches in diameter, used to measure the transparency or clarity of water by noting the greatest depth at which it can be visually detected

TROPHIC PYRAMID – A nutritional organization of organisms, pertaining to the food chain

UPWELLING – Movement of water and nutrients from deep water towards the surface; an important source of nutrients for phytoplankton growth

ZOOPLANKTON – Animal plankton ranging from microscopic larval sea stars to huge jellyfish

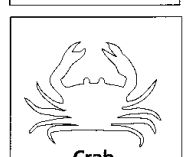
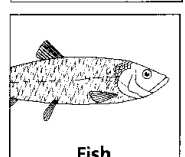
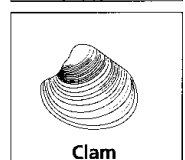
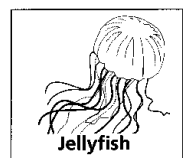
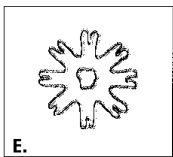
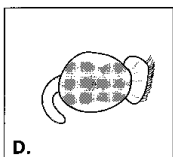
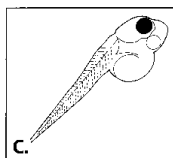
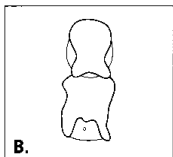
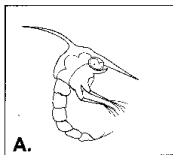




PLANKTON

Of all the living tissue produced in the open oceans and seas, more than 99 percent is plankton! What are they? The word plankton is derived from the Greek word "planktos" which means "drifter." Plankton includes any aquatic organism living unattached and lacking sufficient swimming power to resist most water currents. More simply said, plankton are plants (phytoplankton) and animals (zooplankton) that float at the mercy of the currents or have limited swimming abilities. Many plankters are microscopic and single-celled, others may be half a meter (19 inches) or more across. Plankton includes many young or larval forms of animals that grow and change into adults that look very different from the larvae. The animals hatch from eggs, and the larvae live as zooplankton. Some will remain as plankton for years, others for only weeks.

Can you match the larvae below to their adult forms?



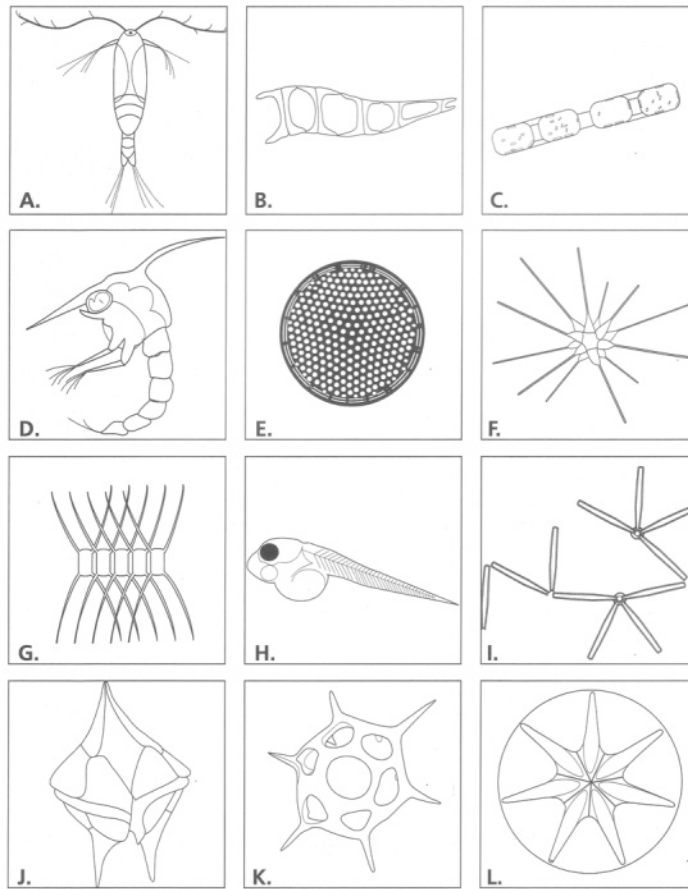
Answer Key: A. crab B. sea star C. fish D. clam E. jellyfish

PLANKTON SORT

Name _____

Date _____

Can you guess which of these are phytoplankton and which are zooplankton? (Hint: "phyto" means plant and "zoo" means animal) Write your answers at the bottom.



A.	_____	E.	_____	I.	_____
B.	_____	F.	_____	J.	_____
C.	_____	G.	_____	K.	_____
D.	_____	H.	_____	L.	_____

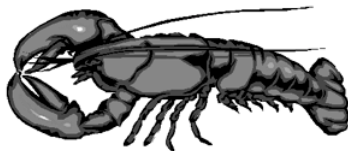
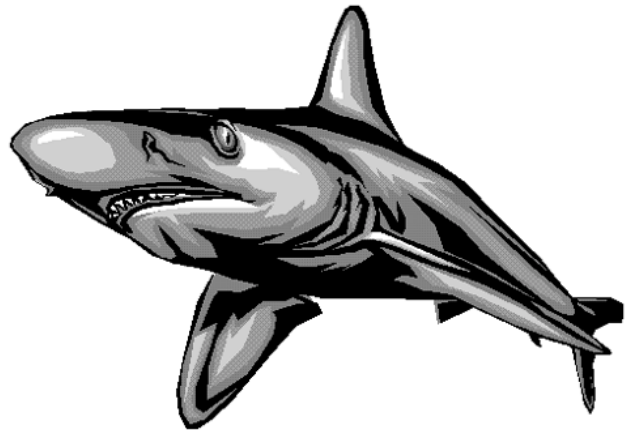
Answer Key: A. zooplankton B. phytoplankton C. phytoplankton D. zooplankton E. phytoplankton F. phytoplankton G. phytoplankton H. zooplankton I. phytoplankton J. phytoplankton K. phytoplankton L. phytoplankton

Food Chains

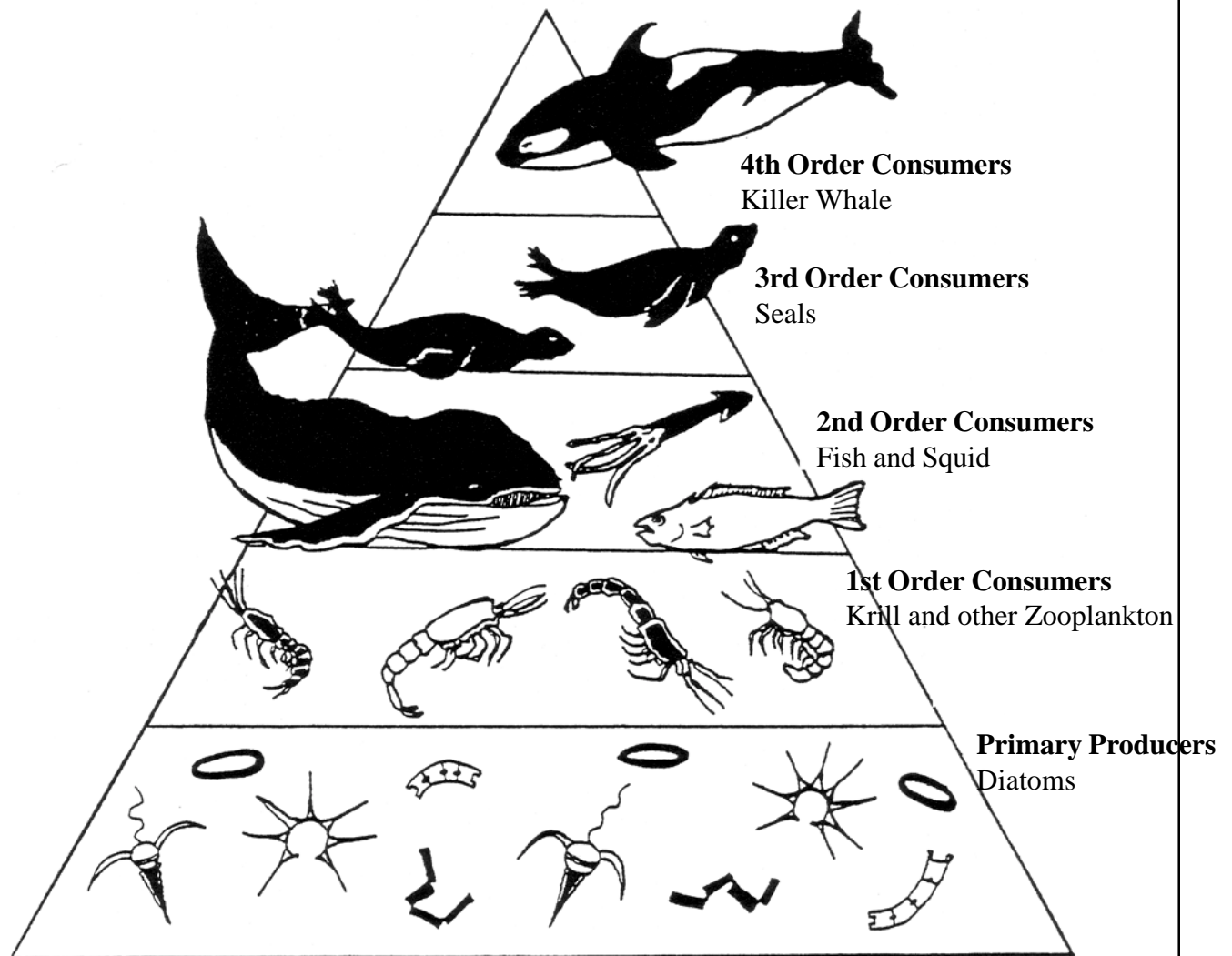
Ocean animals are linked by food chains that make all ocean creatures dependent upon each other. The marine food chain is similar to a pyramid. The few largest creatures at the top could not exist without the layers of increasingly smaller animals below it. Tiny animals eat microscopic plant life and use the nutrients for their own growth. These small animals become food for larger animals. As one animal eats another these nutrients are passed along to each animal.

A humpback whale needs as many as 5,000 herring in its stomach to feel comfortably full. A herring may have 6,000 small crustaceans in its stomach, each of which contains as many as 130,000 diatoms in its stomach. Some four hundred billion diatoms sustain a single medium-sized whale for only a few hours!

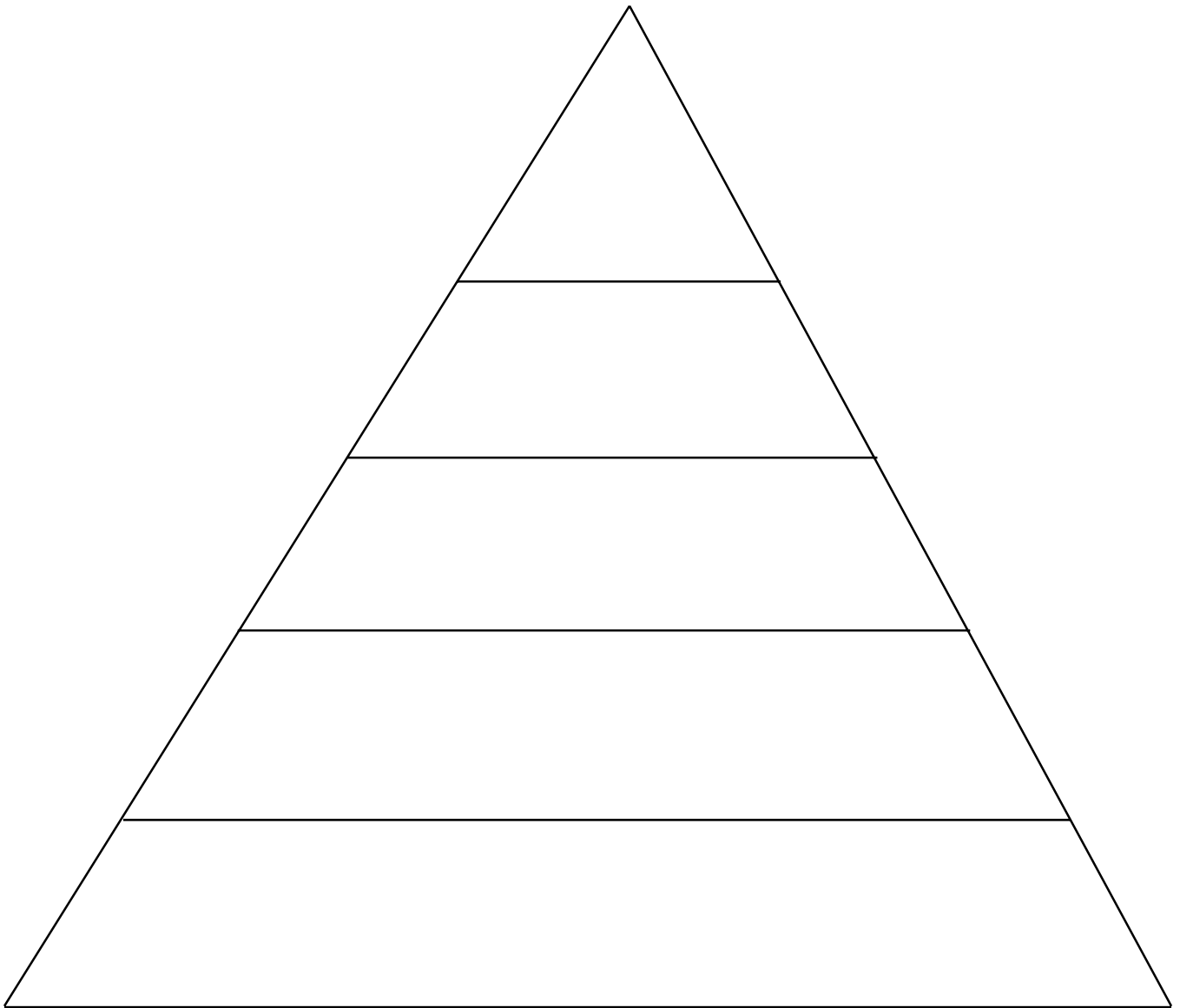
Activity: Cut and paste pictures from the following pages on the food chain pyramid. Consider the size of the animal or plant and arrange the pictures into the pyramid in the most logical place. As you study more about marine life, you may find that your choices may need to be changed.

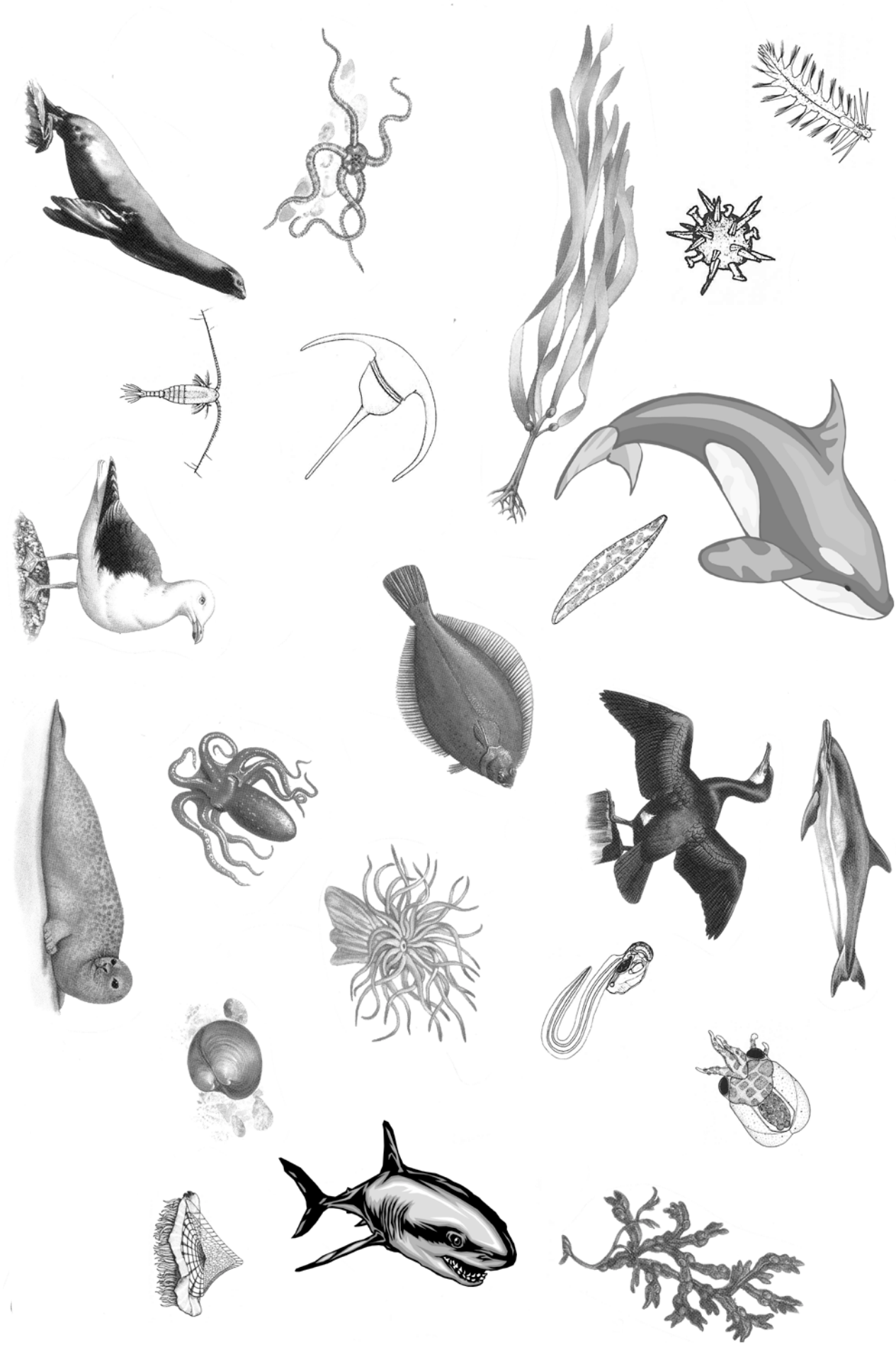


Food Pyramid

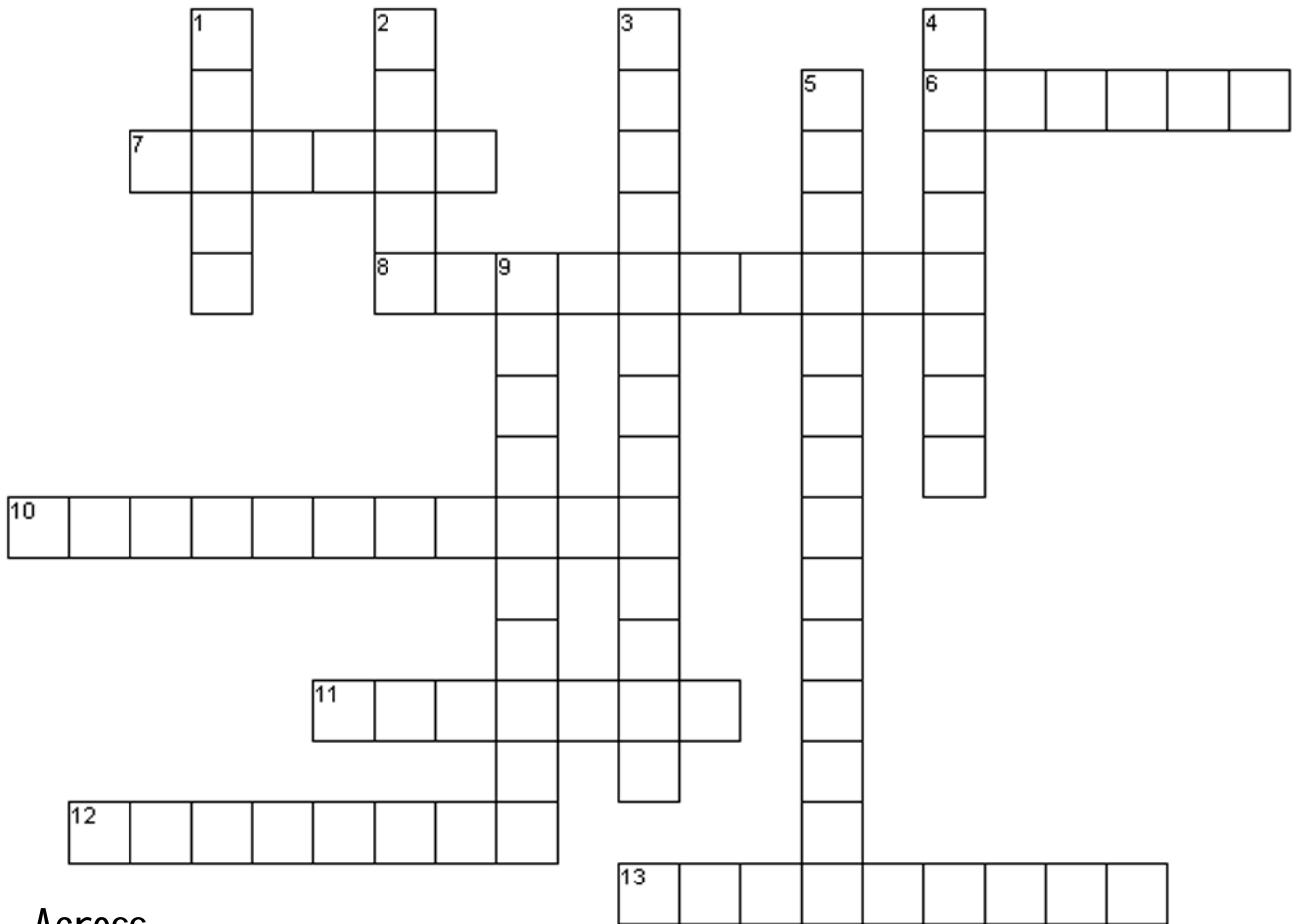


Food Chain Pyramid Activity





PLANKTON PUZZLE



Across

6. The immature juvenile form of an animal
7. Phytoplankton with a glass-like shell made of silica
8. An instrument used to magnify the size of an object for study purposes
10. Animal plankton ranging from microscopic larval sea stars to huge jellyfish
11. An important, abundant zooplankter; tiny crustacean
12. Aquatic organisms that drift with the current or have limited swimming abilities
13. Movement of water and nutrients from deep water towards the surface; an important source of nutrients for phytoplankton growth

Down

1. A two inch long marine crustacean that grows in abundance; an important source of food for some baleen whales
2. A sudden increase in the number of phytoplankton
3. Plant plankton
4. Whip-like extensions of a cell; used in locomotion
5. Phytoplankton often with two whip-like flagella; sometimes poisonous
9. Animals with a tough exoskeleton, jointed appendages & many legs

Marine Ecology





ECOLOGY

Background Information

- ★ Ecology is the study of living things and how they behave and affect one another in their natural environment. It includes studying the consequences that can occur if any part of the relationship between a living thing and the earth is changed or destroyed.
- ★ An ecologist is a person who studies living things and their environment.
- ★ Organisms are living things, including people, animals, plants, bacteria, and fungi.
- ★ Organisms can be classified as producers, consumers, and decomposers.
- ★ Producers are plants that can produce their own food. Consumers are animals that must eat other organisms because they cannot produce their own food. Decomposers are organisms such as bacteria and fungi that feed on dead plants and animals and cause them to decay.
- ★ An ecosystem consists of all the living and nonliving things in a given community. It can include many habitats and different kinds of living things. It can be as small as a puddle of water or as large as an ocean.
- ★ A community is the plants and animals within a given habitat.
- ★ A habitat is the actual place, such as a tree or desert, where an animal or plant lives.
- ★ Homeostasis is the balance in the number of plants and animals in the ecosystem.
- ★ Pollution is anything not from nature that harms the environment.
- ★ When pollutants combine with rainwater, acid rain is formed.
- ★ The average American produces about 3 pounds of trash every day.
- ★ Conservation is the wise use of land and its natural resources in order to prevent abuse, ruin or disregard.
- ★ Preservation is the act of preserving, or keeping intact, the land and its natural resources.
- ★ Reduce means to create less waste. Reuse means to use the same item again or to use an old product for a new purpose. Recycle means to use the material of an old product to make a new product instead of throwing it away.

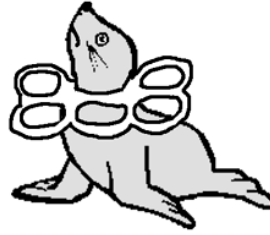


DEBRIS IN THE SEA

Debris (deh-BREE) is another word for trash. For years, the ocean has been used as a dump for trash, sewage, hazardous waste, and pesticides. Plastics are the worst, because they don't break down into safe elements for many, many years. Here are some problems that plastics can cause:



Young seals often play with plastic six-pack rings and get the bands caught around their necks. These bands can strangle them as they grow.



Every year, millions of pounds of plastic fishing nets, buoys, lines and other gear is lost at sea. Whales, seals, and marine birds often become tangled in the gear and get injured or killed.



Sea turtles often feed on plastic bags, mistaking them for jellyfish. Many of these turtles eventually starve to death because the plastic clogs their digestive system.



How Can YOU Help?

In 1998, an international treaty took effect that restricts plastic ocean dumping by the nations that ratified it -- including the United States. But there are still people who litter the beaches and illegally dump trash into rivers and oceans. YOU can help by doing the following:



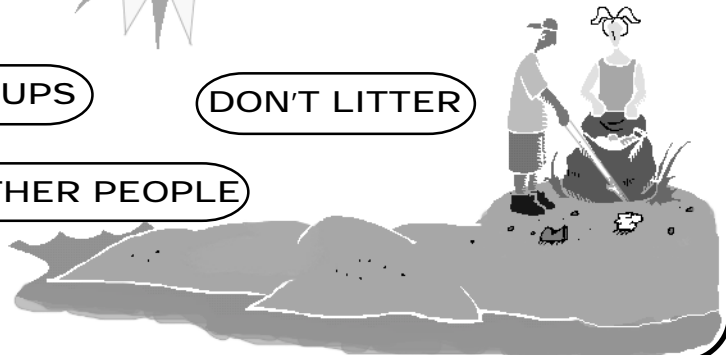
TAKE PART IN BEACH CLEANUP DAYS

SUPPORT ENVIRONMENTAL GROUPS

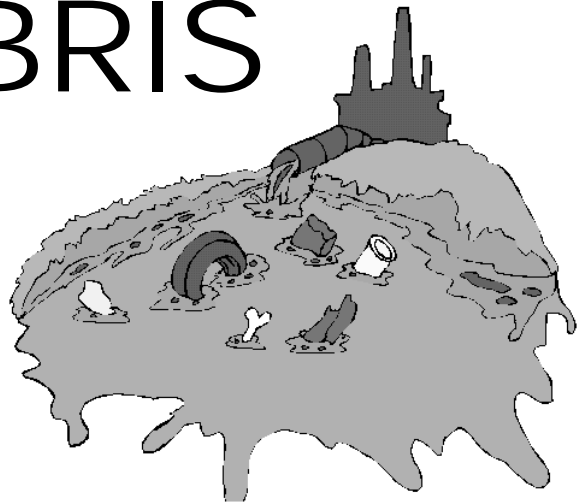
DON'T LITTER

BE A GOOD EXAMPLE TO OTHER PEOPLE

REDUCE-REUSE-RECYCLE



MARINE DEBRIS FACTS AND FIGURES



- Plastics are the most common man-made objects sighted at sea. In a 1988 survey, 89% of the trash observed floating in the North Pacific Ocean was plastic.
- The greatest threats to marine mammals appear to be entanglement and entrapment in lost or discarded fishing nets or other plastic debris, such as uncut strapping bands. Recent studies show that an estimated 30,000 northern fur seals die annually due to entanglement, primarily in net fragments.
- Marine mammals have been reported to eat plastic. Plastic sheeting has been found in the stomachs of pygmy whales, roundtoothed dolphins, and a Cuvier beaked whale.
- Of the world's 280 species of seabirds, 80 species (28%) are known to ingest plastics.
- Sea turtles frequently swallow plastic bags, apparently mistaking them for jellyfish, one of their favorite foods.
- One turtle found in New York had actually consumed 590 feet of heavy duty fishing line.
- On a three mile stretch of beach in Santa Monica, California, an average of 130 tons of trash a month is collected and hauled off the beaches.
- In 1975, the National Academy of Sciences estimated that oceangoing sources dumped 14 billion pounds of garbage into the sea every year more than 1.5 million pounds per hour.
- According to a recent study, the world of fleet vessels (excluding commercial fishing vessels) dumps at least 4,800,000 metal and 300,000 glass containers into the sea every day. This does not include many other kinds of plastic objects being discarded, such as six-pack yokes, eating utensils, plastic sheeting, rope, disposable cigarette lighters, etc.



ECOLOGY expertise

Glossary of basic terms

ACID RAIN - Rain that contains dissolved pollutants

ADAPTATION - A distinct feature of an animal that allows it to survive more easily in its environment

COMMUNITY - All the different plants and animals that live in the same area and are dependent on one another for food and other requirements

CONSERVATION - The wise use of natural resources

CONSUMER - Any organism that feeds on other plants or animals

DECOMPOSER - An organism that breaks down the substance of dead organisms. Mushrooms and bacteria are decomposers

DEGRADABLE - Materials that decompose by the action of bacteria

ECOLOGY - The study of living things in relation to one another and their environment

ECOSYSTEM - An interacting community of animals and plants that depend upon each other and their environment for survival

ENVIRONMENT - All the living and nonliving things with which an organism interacts

FOOD CHAIN - A transfer of food energy from one organism to another

FOOD WEB - A group of interlinked food chains

HABITAT - The physical place where an organism lives

HOMEOSTASIS - The balance in the number of plants and animals in the ecosystem

LANDFILL - A place where solid waste is dumped, burned or buried

MARINE ECOLOGIST - Someone who studies how animals and plants interact with one another in the marine environment

ORGANISM - All living things including people, animals, plants, bacteria and fungi

POLLUTION - Anything not from nature that harms the environment

PRODUCER - A living thing that makes food. Green plants are producers

RECYCLING - Using materials such as paper, glass, plastic or metal over again

SANCTUARY - A safe place of refuge and protection

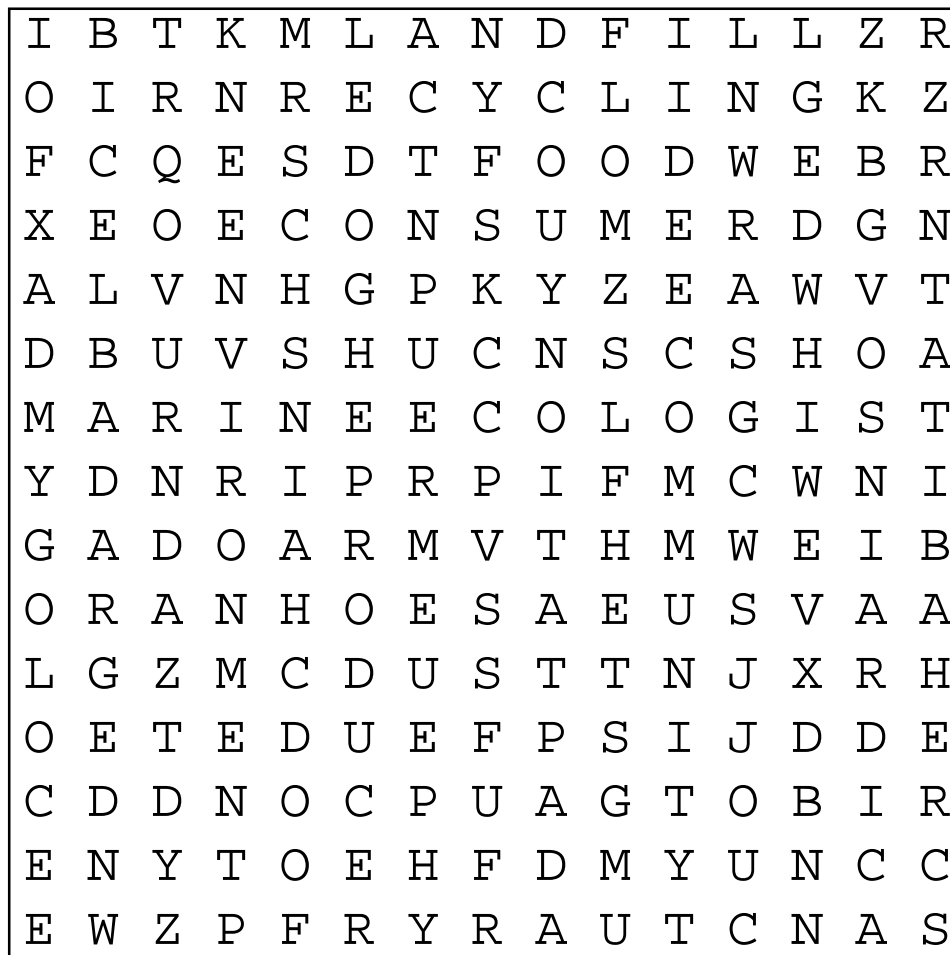
Ecology Vocabulary

Use the words from your Ecology glossary to complete the following sentences.

1. _____ is the study of living things in relation to one another and their environment.
2. An organism that feeds on other plants and animals is a _____.
3. A _____ is a living thing that makes food out of sunlight..
4. Using materials such as paper, glass, plastic or metal over again is called _____.
5. The wise use of natural resources is called _____.
6. The physical place where an organism lives is its _____.
7. A _____ is a group of interlinked food chains.
8. A transfer of food energy from one organism to another is called a _____.
9. An interacting community of animals and plants that depend on each other and their environment for survival is called an _____.
10. Someone who studies how animals and plants interact with one another in the marine environment is called a _____.



ECOLOGY WORD SEARCH



Find and circle these words in the puzzle.

The words read up, down, forward, backward, and diagonally.

ACID RAIN
ADAPTATION
COMMUNITY
CONSERVATION
CONSUMER

DECOMPOSER
DEGRADABLE
ECOLOGY
ECOSYSTEM
ENVIRONMENT

FOOD CHAIN
FOOD WEB
HABITAT
LANDFILL
MARINE ECOLOGIST

PRODUCER
RECYCLING
SANCTUARY

SEAWEEDS

NAME _____

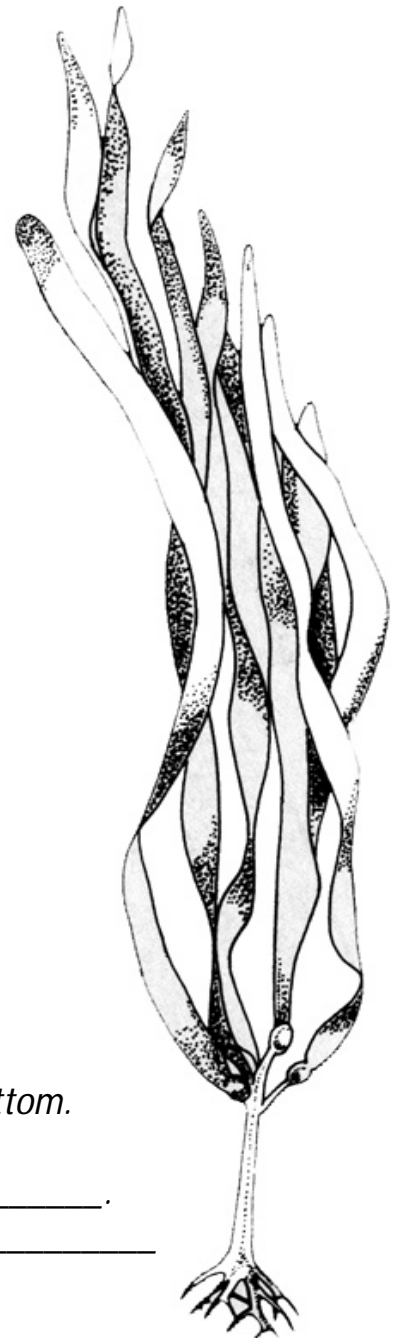
**** Some plants in the sea are very small. They *drift* free. Small plants and animals that drift free are called *plankton*.**

**** Larger plants are called *seaweeds* or *algae*. They have a *holdfast*. The *holdfast* *anchors* the seaweed to the bottom. They also have a *stipe* and *blades*.**

**** Some kinds of seaweeds have *air sacks* on their blades. The air sacks help the seaweeds float. The holdfast, stipe, and blades are similar to the *roots*, *stems*, and *leaves* of a tree.**

**** Seaweeds use their holdfast to attach themselves to *rocks*. Sometimes they attach piggyback on *shellfish*.**

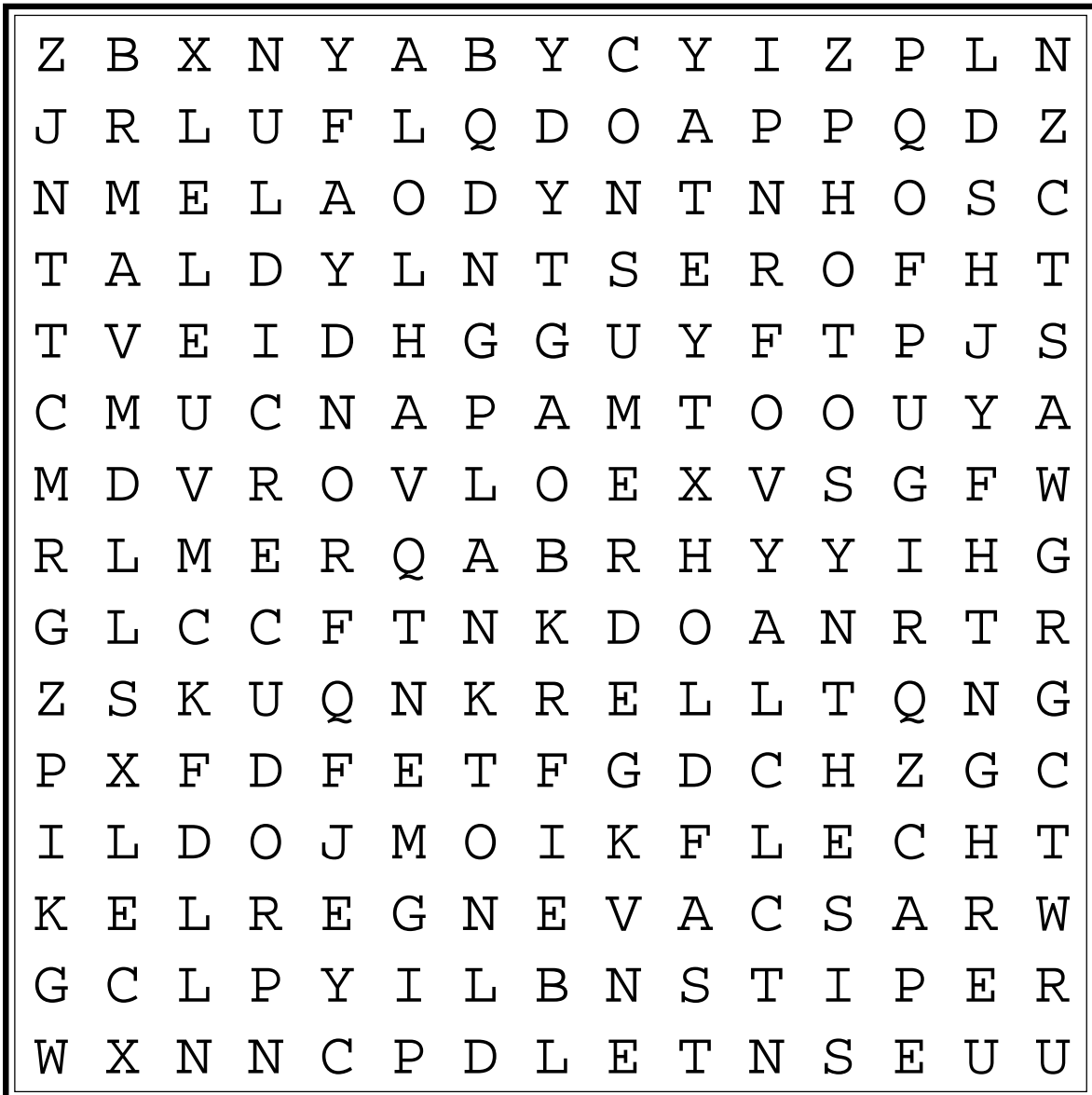
**** Seaweeds make a tasty dinner. Many sea animals eat them. Humans also use seaweeds. They use the *algin* and *carageenan* in food, chemicals, and medicine. Seaweed is used as a thickener in foods like ice cream and pudding.**



Answer the following questions:

1. _____ are small plants and animals that drift in the sea.
2. The _____ holds the seaweed on the bottom.
3. The _____ are like the leaves of a tree.
4. Seaweeds live on _____ and _____.
5. People use _____ and _____ in the production of common foods.
6. Have you ever eaten seaweed? _____

KELP, KELP, AND MORE KELP



ALGAE
ALGIN
BLADDER
BLADE
CANOPY
CHAIN
CHLOROPHYLL

CONSUMER
EAT
FOOD
FOREST
FROND
HOLDFAST
KELP

OCEAN
PHOTOSYNTHESIS
PIGMENT
PLANKTON
PRODUCER
SCAVENGER
STIPE

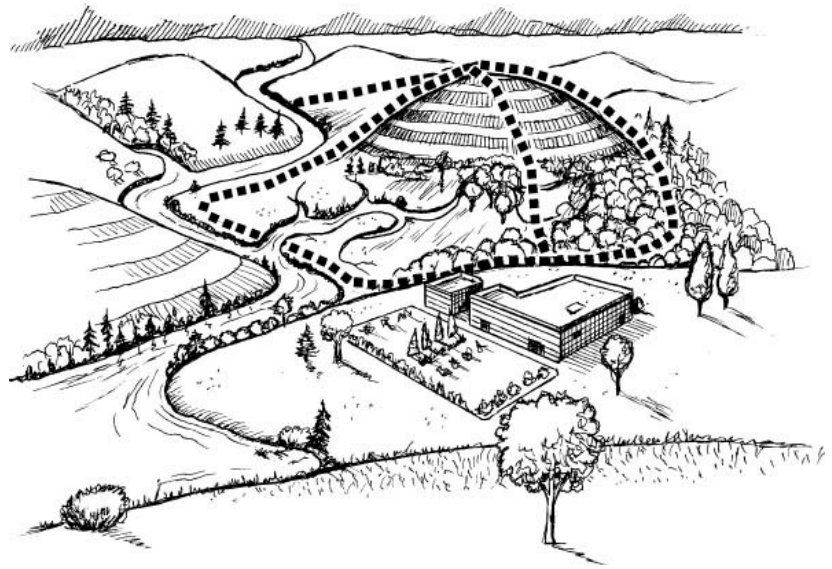
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?**

It's the area of land that catches rain and snow and drains or seeps into a marsh, stream, river, lake or groundwater.

Water carries materials with it wherever it travels. Water naturally travels downhill or downstream. Every creek or stream begins somewhere and connects to other streams. Several or many streams can join to become rivers. Rivers flow to other large bodies of water (lakes, oceans, and seas).

The water used by the people, plants, and animals living downstream is affected by what happens to the water up-stream, and by what happens to it along its journey downstream.

The word "watershed" refers to an area of land drained by a body of water. In other words, a watershed is all of the land surrounding a body of water like the Carmel River. Rainfall falls back to that body of water either directly, like runoff from a nearby street, or indirectly, as with water flowing into the river from small creeks and streams.



Look at the California watershed map to the right. Can you locate your local watershed?

ACTIVITY:

Learn the layout of your watershed

Draw a map of your area; locate your home and your school.

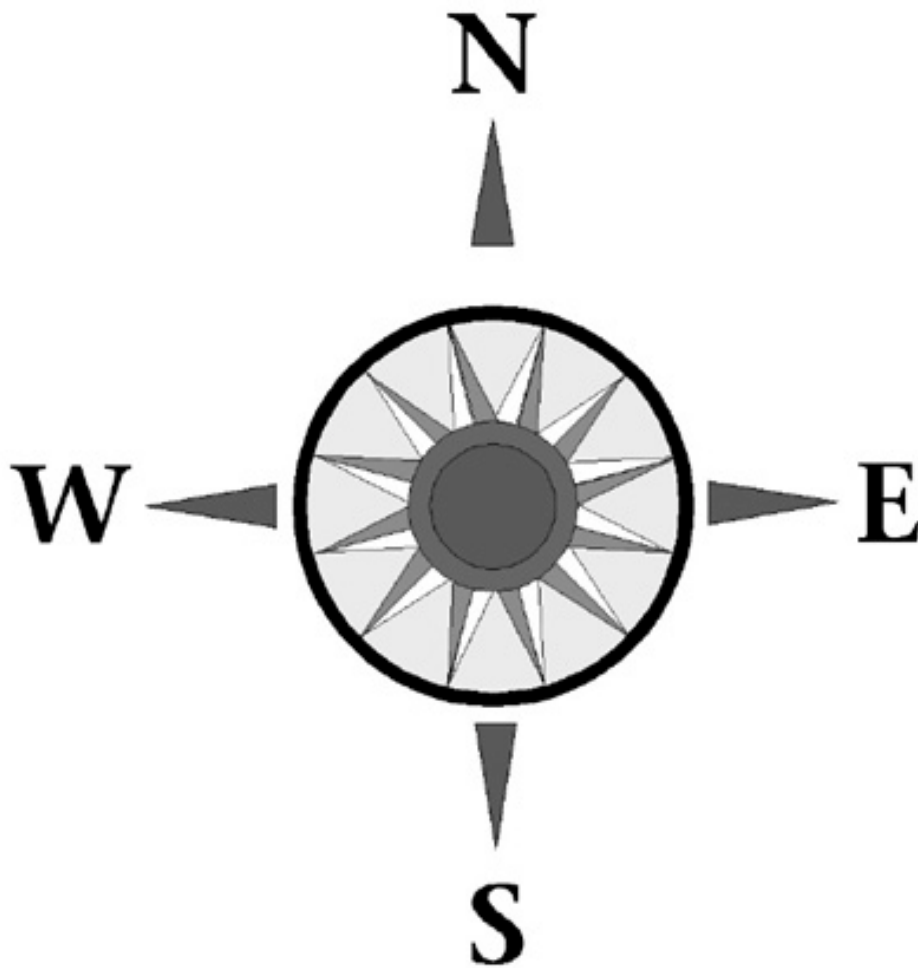


Place the nearest creek, stream or river that drains the area surrounding your home and your school on the map. Does the same watershed cover where you live and where you go to school?

Trace the path of the creek, stream, or river you found as far as you can.

Describe what might happen to a drop of water as it travels through your watershed. What might it pick up going from your home to the ocean or a nearby lake?

Navigation





NAUTICAL KNOW-HOW

Glossary of Basic Terms

BEARING – The direction of an object expressed either as a true bearing as shown on the chart, or as a bearing relative to the heading of the boat

BUOY – An anchored float marking a position on the water, or a hazard or shoal, or for use as a mooring

CATAMARAN – A twin-hulled boat, with hulls side by side

CHART – A map for use by navigators

COMPASS – An instrument used for determining direction, consisting of a magnetic needle freely suspended so that in the earth's magnetic field it turns until aligned with the magnetic north and south poles

COURSE – The direction in which a boat is steered

DEGREE – A directional unit of measurement on a magnetic compass; 1/360 of the circumference. A circle = 360 degrees

ECHO LOCATION – The process of using sound waves or radio waves to locate distant or invisible objects

FATHOM – A unit of measurement used for depth, one fathom is six feet

GPS – Global Positioning System - a navigational system that uses a constellation of 24 earth-orbiting satellites to determine the precise longitude, latitude and altitude anywhere on earth

HEADING – The direction in which a vessel's bow points at any given time

HELM – The tiller or wheel, and surrounding area

KNOT – A unit of speed, one knot = 6,076 feet per hour; or a fastening in rope

LATITUDE – The distance north or south of the equator measured and expressed in degrees

LIGHTHOUSE – A structure with a powerful light that gives a continuous or intermittent signal to navigators

LINE OF POSITION – A line indicating a series of possible positions of a vessel, determined by observation or measurement

LONGITUDE – The distance in degrees east or west of the meridian at Greenwich, England

MINUTE – The 60th part of a degree

NAUTICAL MILE – One minute of latitude; approximately 6,076 feet – about 1/8 longer than the statute mile of 5,280 feet

NAVIGATION – The art and science of conducting a vessel safely from one point to another

PARALLEL RULER – A set of rulers, hinged so that they remain parallel to each other, used to move an angle from a compass rose to a calculated line of position

PORT – The left side of a boat looking forward; or a harbor

RADAR – Radio Detection and Ranging - an instrument that uses high frequency waves to detect the position or movement of objects

RUDDER – A fin under the stern of the boat used in steering

SATELLITE - A celestial body orbiting another of a larger size, or a manufactured object intended to orbit the earth, moon, or another celestial body

SECOND - The 60th part of a minute of angular measure

SOUNDING – A measure of the depth of water

STARBOARD – The right side of the boat when looking forward

TRIANGULATION - The geometric process of determining a geographical position using two or more compass bearings

UNDERWAY – Vessel in motion

WHERE ARE WE GOING?

USING A COMPASS

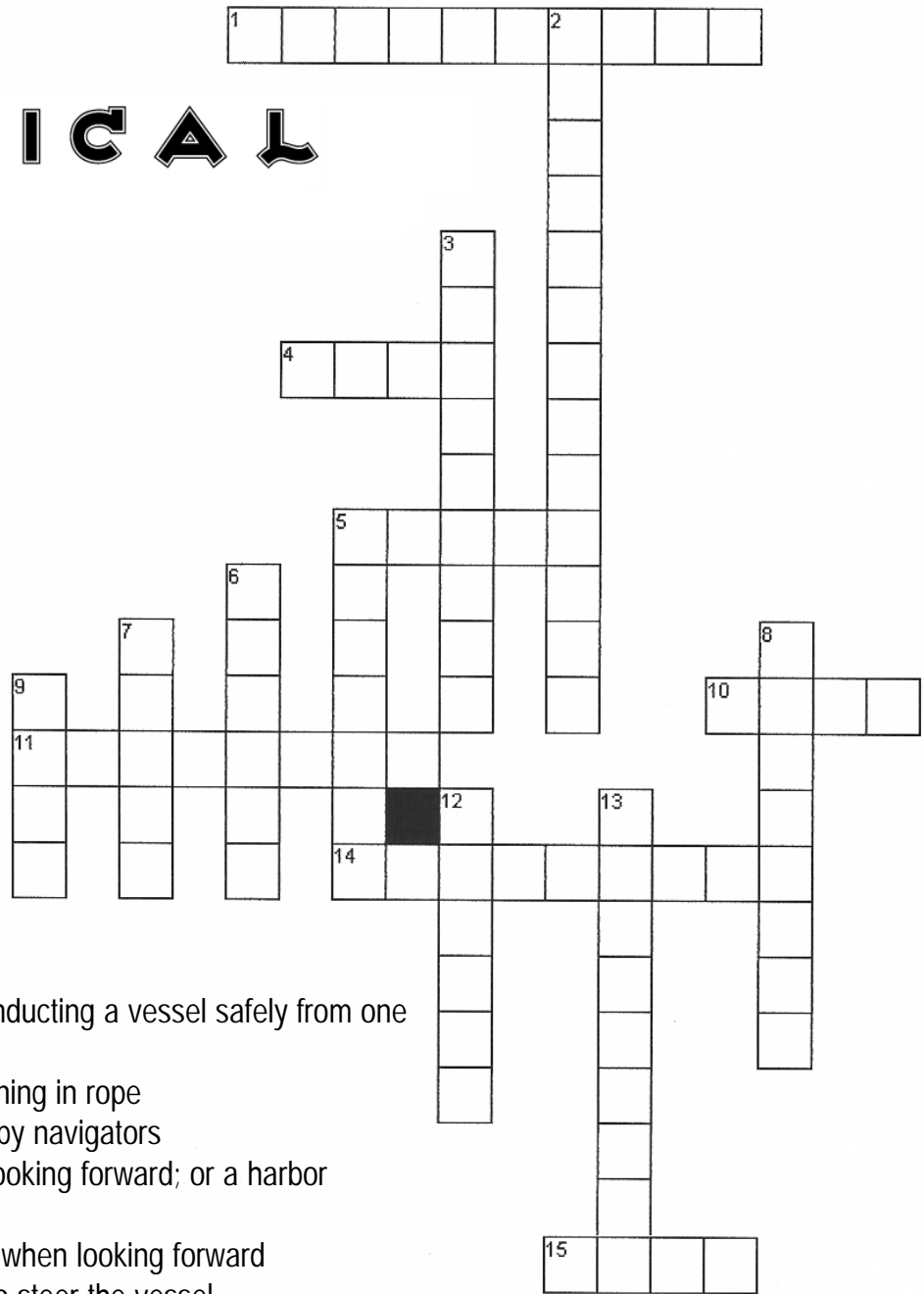
If you want to sail out on the ocean, you aim your vessel at an object and steer toward it, making an allowance for the tide. But what would you do if there was thick fog and you could not see very far in front of you? How could you steer your vessel when you are out at sea and can see no land at all?



The Compass

A compass is an instrument that indicates direction and allows travelers to get from one place to another. The mariner's compass consists of a magnetic needle freely suspended so that in the earth's magnetic field it turns until aligned with the magnetic north and south poles.

K N A U T I C A L O W - H O W



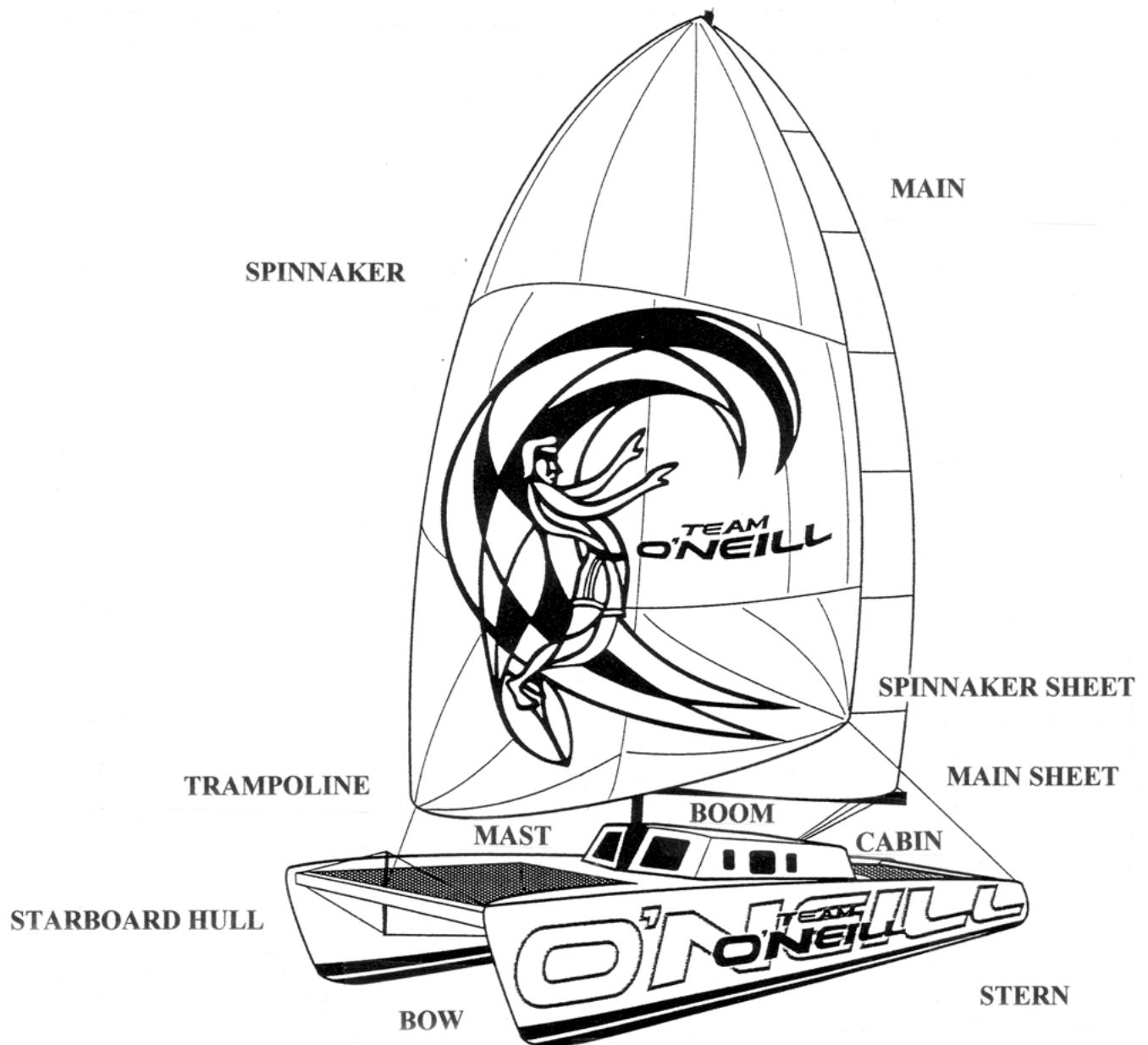
Across

1. The art and science of conducting a vessel safely from one point to the other
4. A unit of speed; or a fastening in rope
5. A map of the ocean used by navigators
10. The left side of the boat looking forward; or a harbor
11. A vessel in motion
14. The right side of the boat when looking forward
15. It is used by the captain to steer the vessel

Down

2. The geometric process of determining a position using two or more compass bearings
3. A boat with two hulls side by side
5. An instrument used for determining direction
6. A directional unit of measurement on a magnetic compass
7. Short for Radio Detection and Ranging; an instrument used to detect the position or movement of objects
8. When you take a measurement of the depth of water, you take a _____
9. An anchored float marking a position on the water
12. A measurement relating to depth; it equals 6 feet

SAILING TERMS



- MAINSAIL - name for the main sail
- SPINNAKER - a large triangular sail
- MAST - upright pole supporting rigging and sails
- BOOM - light beam for stretching bottom of a sail
- STERN - the back part of a boat
- STARBOARD - right side body of boat
- PORT HULL - left side body of boat
- TRAMPOLINE - safety net

NAUTICAL CHARTS

The nautical chart is one of the most fundamental tools available to the sailor; it is the road map of the sea. In the very early days of the United States, commerce between the states was mostly waterborne. Foreign trade, necessary for survival and expansion of our national economy, was entirely by sea. This still holds true today with over 98% of the nation's cargo carried by waterborne transportation a good portion consisting of hazardous cargo posing a continuous threat to the environment.

There are many kinds of charts. Some cover whole oceans, while others show only a length of coastline or a harbor entrance. A chart shows the nature and form of the coast, the depths of the water and general character and configuration of the sea bottom, locations of dangers to navigation, the rise and fall of the tides, locations of man-made aids to navigation, and the characteristics of the Earth's magnetism. Along with other navigational aids, it is used to lay out courses and navigate vessels by the shortest and safest route.

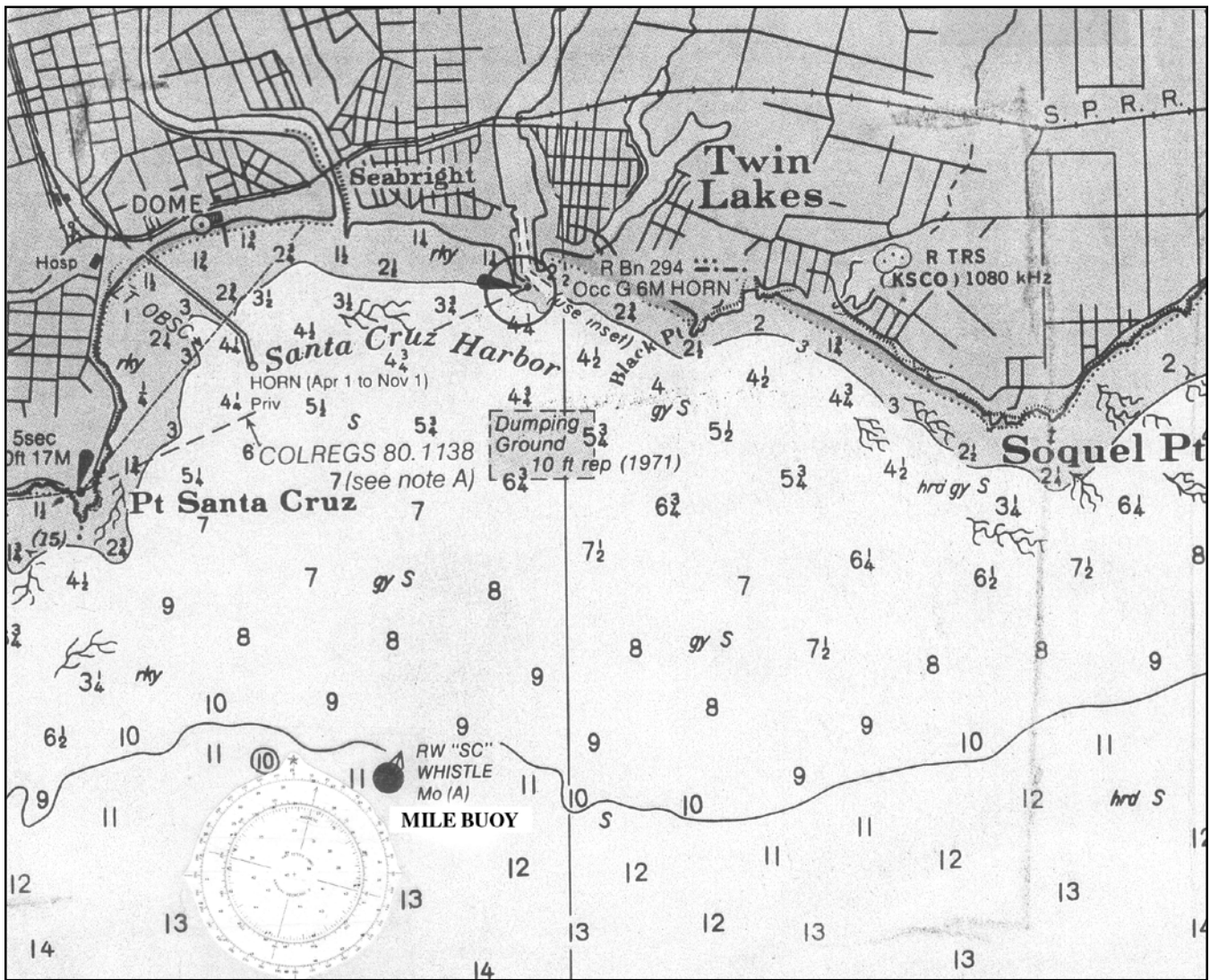


Charts of American waters are published by NOAA (National Oceanic and Atmospheric Association); an agency of the U.S. Department of Commerce.

Charts use many symbols and abbreviations, including features on the land, particularly those that are easily seen and identified from the sea.

A chart tells you not only what you can see, but what you can't see! Look out across a harbor. You can't tell how deep the water is. But the chart and the Tide Tables will tell you. The numbers dotted over the sea areas show you the depths at that point. They are known as soundings. They measure depths in fathoms. Of course the depth will vary as the tide rises and falls. The soundings on a chart always show the least depth that can be expected in that spot the depth at low water springs. All sailors must know the depth of the water if they are to navigate safely.

Here is a section of a chart of the Santa Cruz area of the Monterey Bay.



See if you can find these details on the chart.

***The Lighthouse**

***The Santa Cruz Wharf**

***The Santa Cruz harbor entrance**

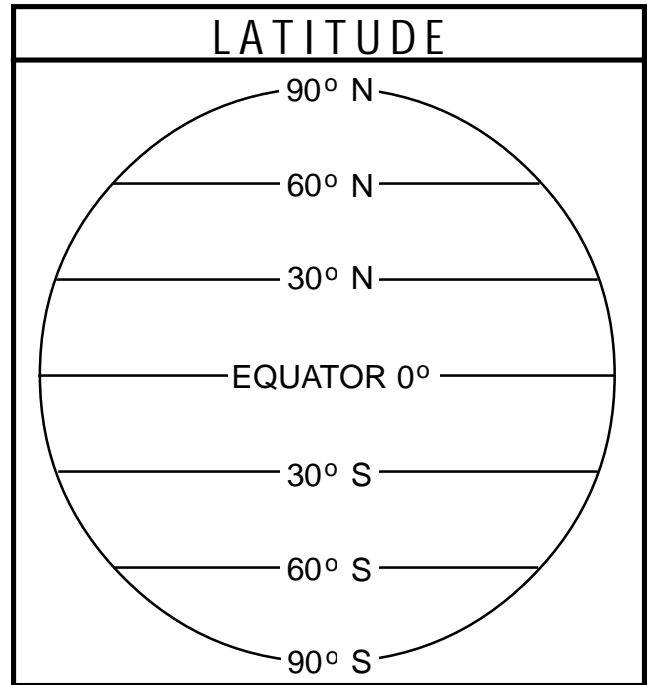
***The one mile buoy**

How deep is the water at the entrance to the harbor?

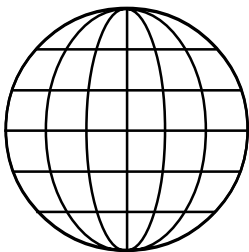
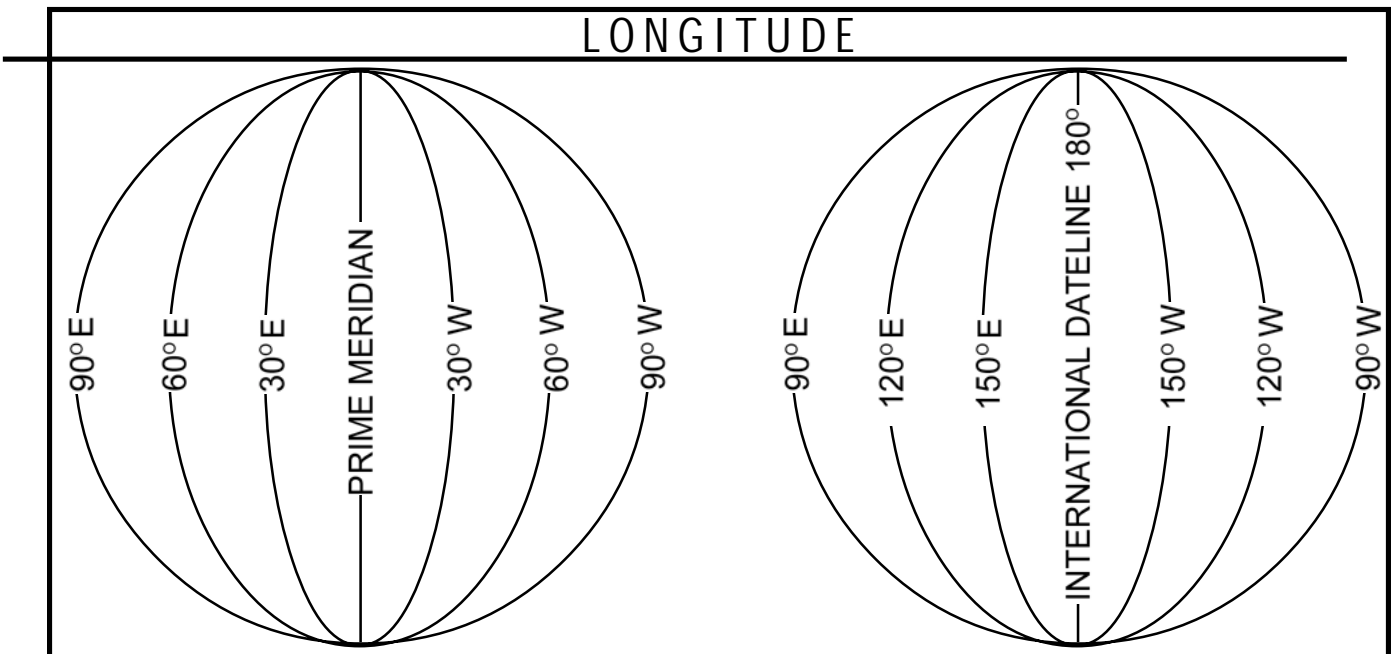
How deep is the water at the one mile buoy?

INTRODUCTION TO LATITUDE AND LONGITUDE

Lines of latitude and longitude are used to chart position on the earth. Lines that run east and west are called lines of latitude. They are written in degrees north and south of the equator. The equator is at 0 degrees latitude, while the North Pole is at 90 degrees North and South Pole is at 90 degrees South. These readings are based on measurements of the angle of the North Star above the horizon at that place. So, if you are at the equator, the North Star is located at the horizon (0 degrees angle) and if you are at the North Pole, the North Star is directly overhead (90 degrees angle).

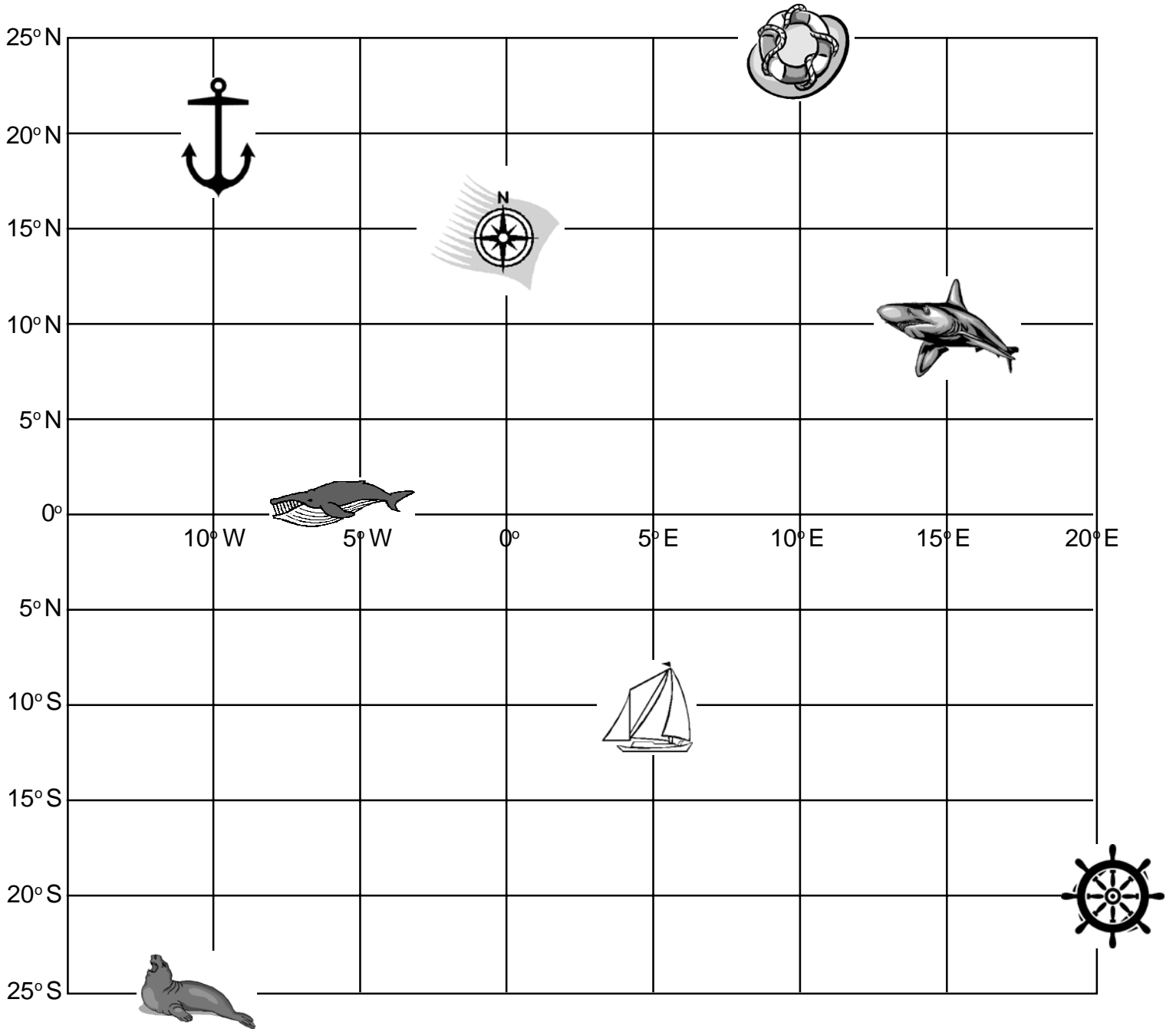


Lines that run north and south are called lines of longitude. Longitude is measured in degrees east and west of the Prime Meridian. The meridian that is halfway around the world from the Prime Meridian is 180 degrees longitude and is called the International Date Line.



Putting the lines of latitude and longitude together, they form a grid. The intersection of the lines gives a point. See the Latitude and Longitude Worksheet.

LATITUDE AND LONGITUDE WORKSHEET

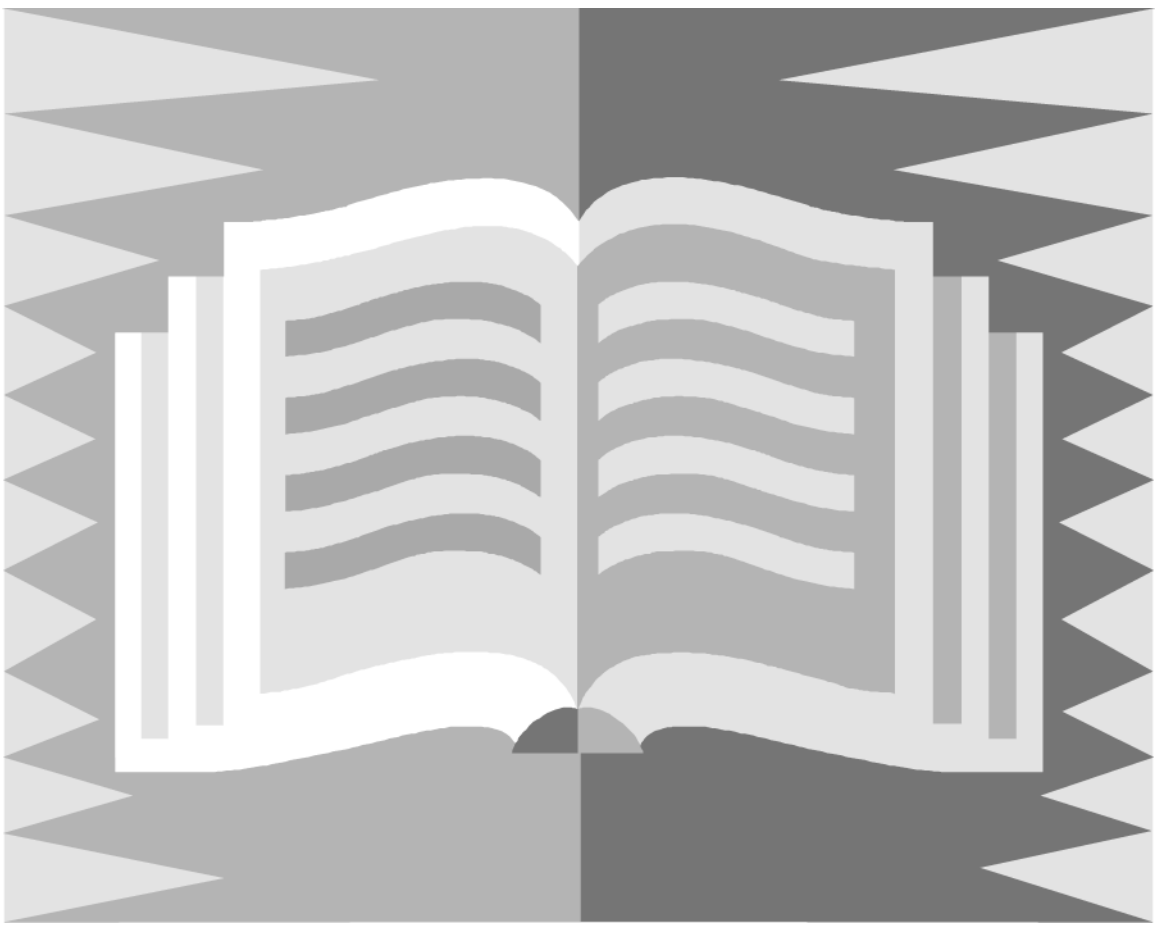


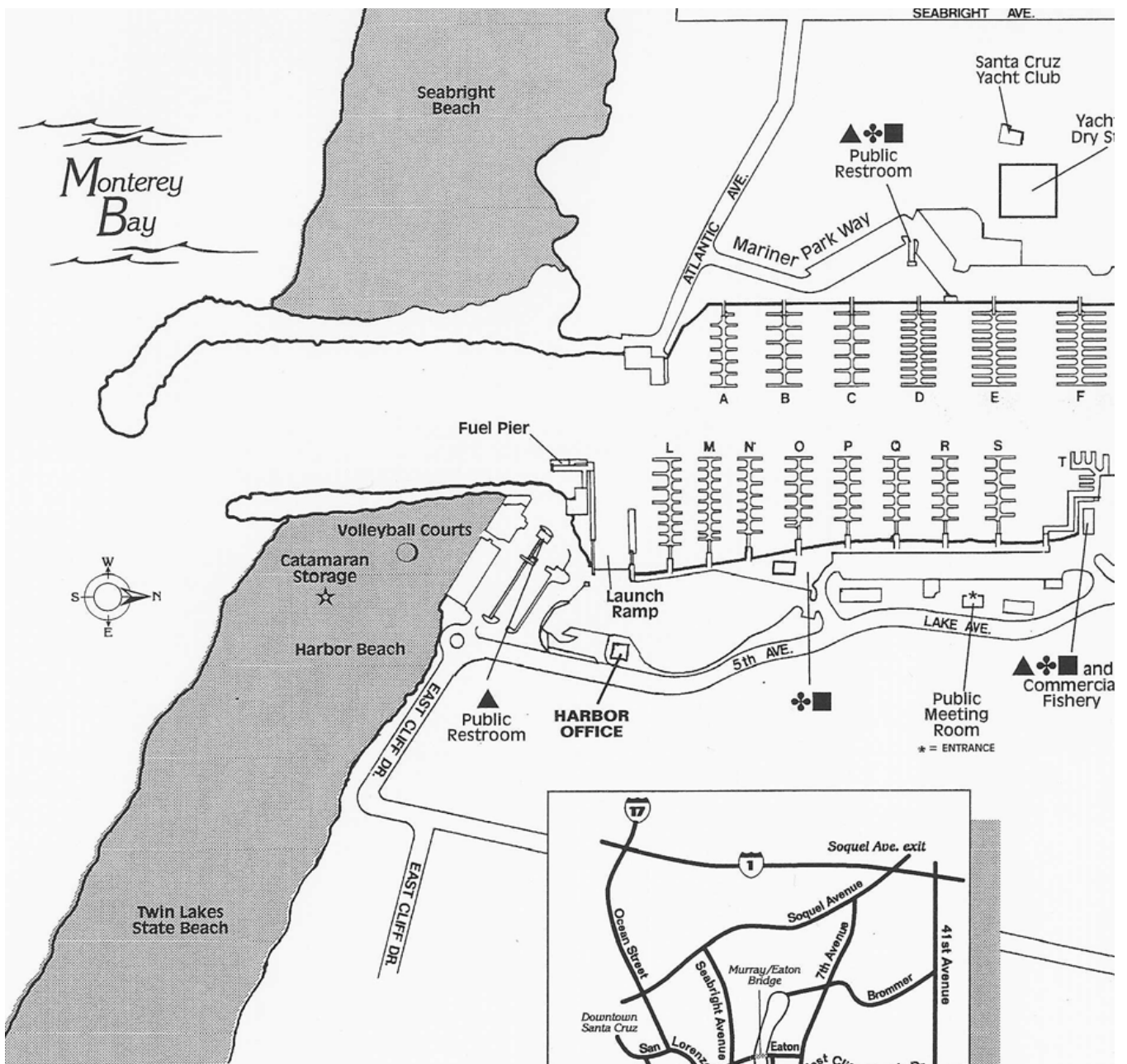
DIRECTIONS:

Locate the latitude and longitude from the center of each picture. Write your answers to the right of each object.

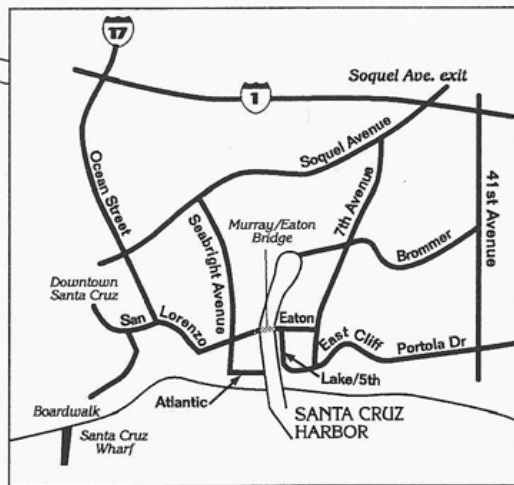
OBJECT	LATITUDE	LONGITUDE
Sea Lion	_____	_____
Compass	_____	_____
Helm	_____	_____
Sailboat	_____	_____
Anchor	_____	_____
Life Ring	_____	_____
Shark	_____	_____
Whale	_____	_____

Extra Activities





- ▲ = Public Restroom
- ♣ = Boaters' Restroom
- ♣■ = Boaters' Restroom/Showers
- = Volleyball Courts
- ☆ = Catamaran Storage



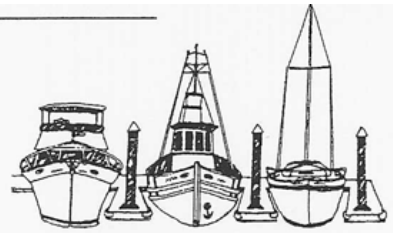
SEABRIGHT AVE.

t Club storage

MURRAY ST.

EATON ST.

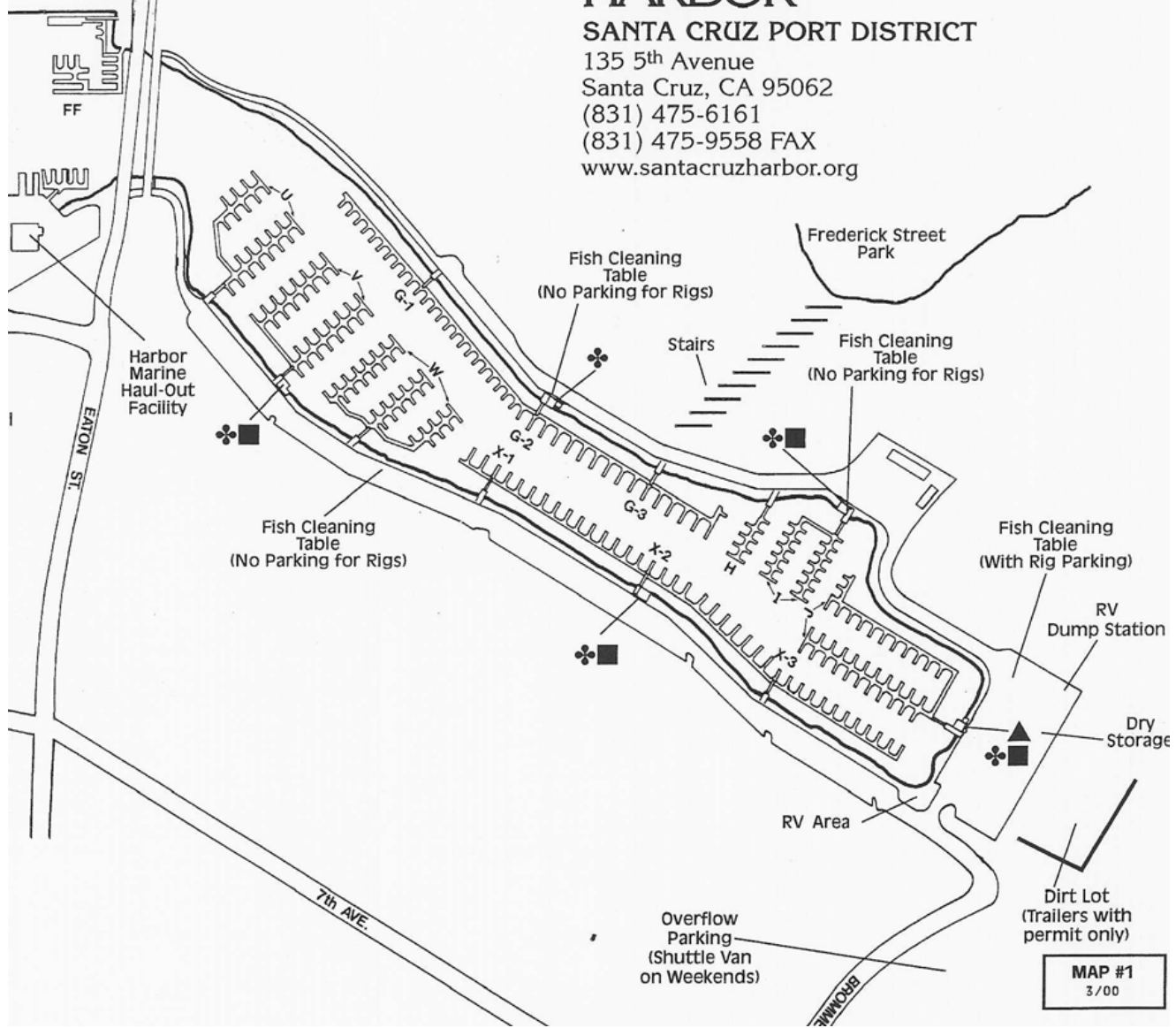
7th AVE.



SANTA CRUZ HARBOR

SANTA CRUZ PORT DISTRICT

135 5th Avenue
Santa Cruz, CA 95062
(831) 475-6161
(831) 475-9558 FAX
www.santacruzharbor.org



MAP #1
3/00

Santa Cruz Harbor

Gateway to the Monterey Bay National Marine Sanctuary

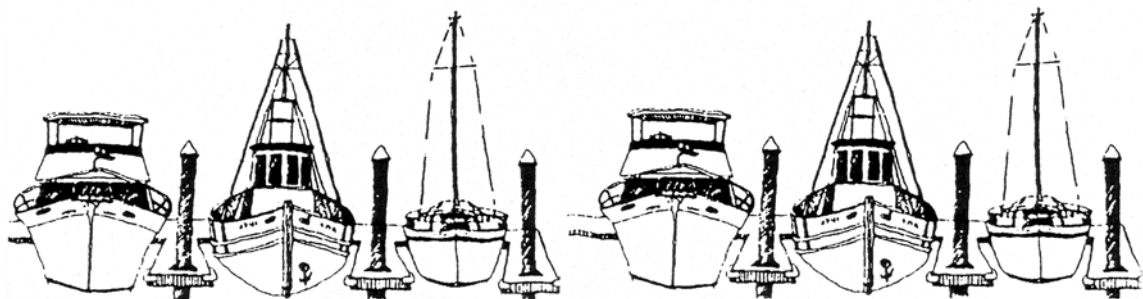
SELF-GUIDED TOUR

Suggested Activity

Before or after participating in the O'Neill Sea Odyssey, you may want to take the self-guided Harbor Tour with your students. Throughout the Santa Cruz Harbor, there are interpretive panels which detail many facets of the harbor's ecosystems, economics, and history. Most panels are located at the water's edge and are easy to find by the bright yellow and blue metal sign with rounded tops which denote their location. The following set of questions could be given to small groups of students to complete and take back to the classroom for discussion. There is a great deal to be learned from the Harbor Tour. Enjoy!

Santa Cruz Port District

135 Fifth Avenue
Santa Cruz, CA 95062
831-475-6161
831-475-9558 FAX



HARBOR STATION TOUR

Located throughout the harbor are interpretive panels. Provided below are questions related to each. Since their locations change periodically, the list is alphabetical by panel title.

BIRDS OF THE SANTA CRUZ SMALL CRAFT HARBOR



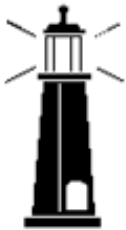
Name three birds found at the Santa Cruz Small Craft Harbor – give one fact about each:

1. _____
2. _____
3. _____

Look around you. Count how many live birds you see. _____

Which bird weighs only 1 pound and flies 50 miles per hour? _____

BUILDING THE WALTON LIGHTHOUSE



How high is the Walton Lighthouse?

_____ feet above water level

_____ feet above the jetty

How did harbors signal mariners before the invention of the lighthouse?

THE EVOLUTION OF SAILING VESSELS



Name 3 vessels and give one fact about each

1. _____
2. _____
3. _____

SOME FISH FROM MONTEREY BAY



How big can an average Chinook salmon get? _____

What is the record? _____ pounds

Name one other fish that can grow up to over 50 lbs. _____

Which fish weighs the most? _____

A HISTORY OF THE MARINE COMPASS



Name three types of compasses:

1. _____
2. _____
3. _____

JETTIES



Why are the jetties hazardous in stormy weather?

What is a tetrapod? _____

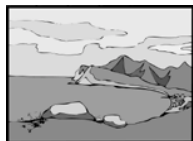
How many are there in the west jetty? _____

How much does each one weigh? _____

Why were the jetties built? _____

What childrens game were the tetrapods designed after? _____

MONTEREY BAY NATIONAL MARINE SANCTUARY



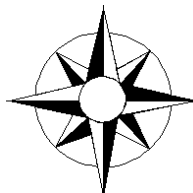
About how big is the Monterey Bay National Marine Sanctuary?

It stretches from the _____ in the North to the city of _____ in the South.

Who first explored the Bay in 1602? _____

How deep is the Monterey Canyon? _____

NAVIGATION INSTRUMENTS...OLD AND NEW



Name one type of navigation:

1. _____

Celestial navigation is using sights and measurements of the positions of the _____ to determine courses and positions.

A primitive compass consisted of an earthen bowl filled with _____

Name 2 of the 8 things that the Global Positioning Instrumentation can tell you:

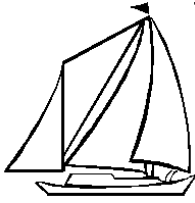
1. _____

2. _____

To function the compass depends upon and aligns with the Earths _____

In the Chinese Floating Needle Compass a magnetized needle is floated on bits of _____ in a bowl of _____ and _____.

THE PHYSICS OF SAILING



_____ are the engines of the earth.

Name the 4 sailing directions:

1. _____
2. _____
3. _____
4. _____

A sailboat cannot sail directly into the wind. To reach upwind destinations it must _____ back and forth.

PINNIPEDS OF THE MONTEREY BAY



Where do elephant seals breed? _____

What type of Pinniped is spotted? _____

Name the types of sea lions that live in the Monterey Bay.

1. _____
2. _____

SANTA CRUZ MILE BUOY



Who put the mile buoy in the bay? _____

Why was the mile buoy placed there? _____

What is the latitude and longitude of the mile buoy?

_____ latitude _____ longitude

How long is the chain that attaches the mile buoy to the sea floor?

_____ feet.

THE SANTA CRUZ SMALL CRAFT HARBOR



What does the harbor offer? _____

What is the name of the lagoon that the Harbor was built on?

What do you see at the end of the jetty? _____

THE SANTA CRUZ SMALL CRAFT HARBOR -

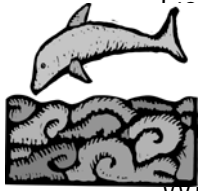
DREDGE SEABRIGHT AND DREDGE TENDER DAUNTLESS



What is the purpose of the dredge? _____

What is the snorkel head used for? _____

SOME MARINE MAMMALS OF MONTEREY BAY



Unit 3 – give one fact about each:

1. _____
2. _____
3. _____

Where do elephant seals breed that is 19 miles from here?

Name two things sea otters feed on:

1. _____
2. _____

TIDES AND TERMINOLOGY



What is the distance from the Earth to the Moon? _____ miles

What is the distance from the Earth to the Sun? _____ miles

The 3 types of tides are Semi-Diurnal, Mixed, and Diurnal. The Monterey Bay is a _____ tide locale.

Tide ranges in the Monterey Bay approximate a maximum of _____ feet between high and low tides.

THE TREES OF SANTA CRUZ HARBOR



Find the Blue Heron – What kind of tree is it sitting in?

About how old is the Coast Live Oak in the picture? _____

Name two other trees that are found in the Santa Cruz Harbor.

1. _____
2. _____

What did coastal tribes use the pods of the California Buckeye tree for? _____

WHALES



How large can the Blue Whale get to be? _____

Where do humpbacks winter? _____

How often do Gray Whales give birth? _____

About how long is the Gray Whale migration? _____ miles

Gray Whales spend spring and summer in the _____ and winter in warm waters off the coast of _____

HARBOR TOUR ANSWER KEY

BIRDS

Name three birds found at the Santa Cruz Small Craft Harbor – give one fact about each:

1. Answers will vary
- 2.
- 3.

Look around you. Count how many live birds you see.

Which bird weighs only 1 pound and flies 50 miles per hour? Cinnamon Teal

BUILDING THE WALTON LIGHTHOUSE

How high is the Walton Lighthouse?

59.5 feet above water level

41.5 feet above the jetty

How did harbors signal mariners before the invention of the lighthouse?

Signal fires

THE EVOLUTION OF SAILING VESSELS

Name 3 vessels and give one fact about each

1. Answers will vary – (Schooners, Nile Craft, Chinese Junk, The Sloop, Spray,
2. Chardonnay II The Sloop)
- 3.

SOME FISH FROM THE MONTEREY BAY

How big can an average Chinook salmon get? Up to 50 lbs.

What is the record? 126 ½ pounds

Name one other fish that can grow up to over 50 lbs. Giant Sea Bass (over 500)

Which fish weighs the most? The Giant Sea Bass

A HISTORY OF THE MARINE COMPASS

Name three types of compass:

- 1.
2. (Possible answers - The Binnacle, Chinese Loadstone Spoon Compass,
3. Gyrocompass, Modern Marine Magnetic Compass)

JETTIES

Why are the jetties hazardous in stormy weather? The water can come over and knock you off

What is a tetrapod? A concrete "jack" used to lend stability to the jetty

How many are there in the west jetty? 900

How much does each one weigh? 25 tons

Why were the jetties built? To protect the harbor entrance and control the incursion of sand into the harbor mouth

What childrens game were the tetrapods designed after? Jacks

MONTEREY BAY NATIONAL MARINE SANCTUARY

About how big is the Monterey Bay National Marine Sanctuary? Nearly 4,000 nautical miles
It stretches from the Farallones National Marine Sanctuary in the North to the city of Cambria in the South.
Who first explored the Bay in 1602? Sebastian Vizcaino
How deep is the Monterey Canyon? 7,000 feet

NAVIGATION INSTRUMENTS... OLD AND NEW

Name one type of navigation:

1. (Answers will vary - dead reckoning, pilotage, celestial navigation, radio navigation)

Celestial navigation is using sights and measurements of the positions of the heavenly bodies to determine courses and positions.

A primitive compass consisted of an earthen bowl filled with water.

Name 2 of the 8 things that the Global Positioning Instrumentation can tell you:

1. (Possible answers - Exact latitude/longitude, Speed and course of the vessel, Display of
2. appropriate charts, Time, Water temperature, Bearing and wayprints, Depth and contour of sea bottom, Representation of selected coastlines, Intended course and past track).

To function the compass depends upon and aligns with the Earth's magnetic field.

In the Chinese Floating Needle Compass a magnetized needle is floated on bits of straw in a bowl of oil and water.

THE PHYSICS OF SAILING

Winds are the engines of the earth.

Name the 4 sailing directions:

1. Close hauled
2. Close reach
3. Broad reach
4. Run

A sailboat cannot sail directly into the wind. To reach upwind destinations it must tack back and forth.

PINNIPEDS OF THE MONTEREY BAY

Where do elephant seals breed? Ano Nuevo, 19 miles north of Santa Cruz

What type of Pinniped is spotted? Harbor seal

Name the types of sea lions that live in the Monterey Bay.

1. California Sea Lion
2. Stellar Sea Lion

SANTA CRUZ MILE BUOY

Who put the mile buoy in the bay? The United States Coast Guard

Why was the mile buoy placed there? They wanted to mark a reference point to the Santa Cruz Harbor and the Municipal Wharf

What is the latitude and longitude of the mile buoy?

36° 45 ' 11 " latitude 122 ° 25 ' 21 " longitude

How long is the chain that attaches the mile buoy to the sea floor? 260 feet.

THE SANTA CRUZ SMALL CRAFT HARBOR

What does the harbor offer? A natural safe haven where boats can be moored and protected

What is the name of the lagoon that the Harbor was built on? Woods Lagoon

What do you see at the end of the jetty? The lighthouse

THE SANTA CRUZ SMALL CRAFT HARBOR -

DREDGE SEABRIGHT AND DREDGE TENDER DAUNTLESS

What is the purpose of the dredge? To keep the harbor mouth clear

What is the snorkel head used for? To remove sand from the bottom

SOME MARINE MAMMALS OF MONTEREY BAY

List 3 – give one fact about each:

1. (Answers will vary - Northern Elephant Seal, California Sea Lion, Sea Otter,

2. Northern Steller Sea Lion, Harbor Seal)

3.

Where do elephant seals breed that is 19 miles from here? Ano Nuevo

Name two things sea otters feed on:

1. (Answers will vary - sea urchins, abalone, clams, and mussels)

2.

TIDES AND TERMINOLOGY

What is the distance from the Earth to the Moon? 238,860 miles

What is the distance from the Earth to the Sun? 92,900,000 miles

The 3 types of tides are Semi-Diurnal, Mixed, and Diurnal. The Monterey Bay is a mixed tide locale.

Tide ranges in the Monterey Bay approximate a maximum of 8 feet between high and low tides.

THE TREES OF SANTA CRUZ HARBOR

Find the Blue Heron – What kind of tree is it sitting in? Coast Redwood – Sequoia Sempervirens

About how old is the Coast Live Oak in the picture? About 250 years old

Name two other trees that are found in the Santa Cruz Harbor. Eucalyptus and Cypress

What did coastal tribes use the pods of the California Buckeye tree for? To stun fish

WHALES

How large can the Blue Whale get to be? 100 feet and can weigh as much as 90 to 100 tons

Where do humpbacks winter? Mexican and Hawaiian waters

How often do Gray Whales give birth? About every other year

About how long is the Gray Whale migration? 10,000 miles

Gray Whales spend spring and summer in the North Pacific and winter in warm waters off the coast of Baja California.

Teacher Resources and Literature List

Alligators to Zooplankton: A Dictionary of Water Babies
by Les Kaufman and staff, New England Aquarium (Watts,
1991)

***Beneath the Waves: Exploring the Hidden World of the
Kelp Forest*** by Norbert Wu (Chronicle, 1992)

***Chains, Webs and Pyramids: The Flow of Energy in
Nature*** by Laurence Pringle (Crowell, 1975)

A Child's Treasury of Seaside Verse by Mark Danile (Dial,
1991)

Common Ground : The Water, Earth, and Air We Share
by Molly Bang (Scholastic Inc., 1997)

Dear Children of the Earth by Schim Schimmel
(Northwood Press, 1994)

Discovering Jellyfish by Marianda Macquitty (Watts, 1989)

***Don't Blink Now! Capturing the Hidden World of Sea
Creatures*** by Ann Downer (Watts, 1991)

Marine Biology, An Ecological Approach by James W.
Nybakken (Harper & Row, 1988)

Monsters of the Deep by Norman Barrett (Watts, 1991)

Our Big Home: An Earth Poem by Linda Glaser (The
Millbrook Press, Inc., 2000)

Pagoo by Holling Clancy Holling (Houghton Mifflin,
1985)

Plankton: Drifting Life of the Waters by Julian May
(Holiday, 1972)

Pollution and Waste (Young Discoverers Series) by Rosie
Harlow and Sally Morgan (Kingfisher, 1995)

A River Ran Wild by Lynne Cherry (Harcourt Brace
Jovanovich, 1992)

Sea Soup – Phytoplankton by Mary M. Cerullo (Tilbury
House Publishers, 1999)

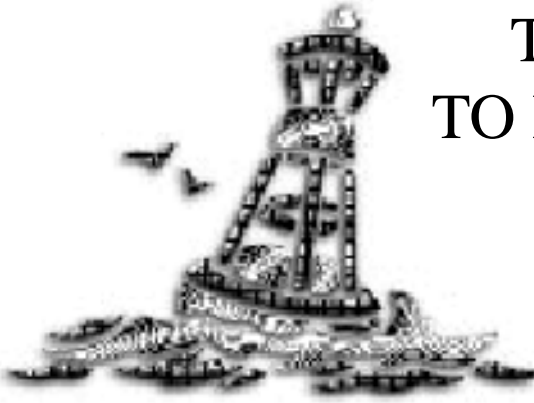
***Sea Soup Teacher's Guide – Discovering the Watery
World of Phytoplankton and Zooplankton*** by Betsy T.
Stevens (Tilbury House Publishers, 1999)

Starfish by Edith Hatcher Hurd (Harper, 1962)

The Sea is Calling Me by Lee Bennett Hopkins (Harcourt,
1986)

The Ultimate Ocean Book by Maria Mud-Ruth (Western)

Young Sailor : An Introduction to Sailing and the Sea by
Mark A. Bashforth (Sheridan House, 1993)



THINGS YOU CAN DO TO PROTECT OUR OCEANS

Learn all you can.

Read, surf the Web and experience the ocean directly.

Be a smart shopper.

Learn more about the source and quality of your seafood.

Conserve water.

Be careful when washing your car or watering your lawn. Use a broom instead of a hose to clean your driveway or sidewalk.

Reduce household pollutants.

Cut down and properly dispose of herbicides, pesticides and cleaning products.

Reduce waste.

Dispose of trash properly. Where possible, recycle, re-use, and compost.

Reduce automobile pollution.

Use fuel efficient vehicles or carpool. Recycle motor oil and repair oil and air conditioning leaks.

Protect ocean wildlife.

Don't dispose of fishing lines, nets or plastic items in or near the water.

Be considerate of sealife habitats.

Don't feed sea birds, mammals and turtles or disturb their nesting grounds. Support marine protected areas.

Get involved.

Take part in a beach cleanup or other ocean-oriented activities.

Care! Pass on your knowledge!



NAVIGATION tERmS

(Spanish Translation)

buoy	boya
chart	carta de navegación
circle	circulo
compass	compás
degree	grado
dividers	divisor
east	este
house	casa
latitude	amplitud
light (lighthouse)	luz (faro)
line of position	linia de lugar
longitude	longitud
map	mapa
mile	milla
minute	minuto
navigation	navegación
north	norte
parallel ruler	regla paralela
plot	trazar (to chart)
radar	radar
satellite	satélite
second	segundo
south	sur
triangulation	triangulación
west	oeste





mARiNE BiOLOGy tERmS

(Spanish Translation)

chlorophyll	clorofila
clarity	claridad
consumer	consumidor
copepod	---
depth	profundidad
depth finder	buscador de profundidad
diatom	---
dinoflagellate	---
food chain	cadena alimenticia
krill	camarón antártico
larvae	larva
microscope	microscopio
nutrient	nutritivo
photosynthesis	fotosíntesis
phytoplankton	fitoplancton
plankton	plancton
plankton net	red para plancton
primary producer	productor primario
salinity	salinidad
Secchi disc	disco Secchi
thermometer	termómetro
trophic pyramid	---
turbidity	turbidad
water	agua
water temperature	temperatura del agua
zooplankton	zooplancton





ECOLOGY tERmS

(Spanish Translation)

anchovy	anchoa
conserve	conservar
food chain	cadena alimenticia
fur	pelo
garbage	basura (to throw = tirar)
habitat	hábitat
kelp forest	bosque de kelp
motor oil	aceite
ocean	mar
plankton	plancton
pollution	contaminación
protect	proteger
rain	lluvia
recycle	reciclar
reduce	reducir
reuse	volver a usar
salmon	salmón
sanctuary	santuario
seal	foca
sea otter	nutria
shellfish	crustáceo (eating: mariscos)
shark	tiburón
storm drain	desaguadero
toxic waste	basura tóxico
watershed (or river)	vertiente (rio)



EXTRA ACTIVITIES

TRASH ART COLLAGE

Begin this art project by asking students to collect cans, bottles, straws, Styrofoam containers, cups, wrappers, boxes, rubber bands, wire, bottle caps, magazines, and any other materials that have been discarded. Rinse all containers to remove drink remains or food particles.



Let the students select objects from the collected supplies for their art project. The objects may be bent, crushed, stretched or folded into various shapes and attached to a piece of poster board with glue, staples or wire. Let the students display and explain their collages when completed. Then, display the collages in the classroom or school.

ECOLOGY MURALS

Divide your class into smaller groups. Assign each group an ecological community. Each group will research to find out what plants and animals are found in the community. Give each group a large piece of butcher paper on which it can make a mural depicting the assigned community. Encourage the students to be creative. Have students attempt to make part of the mural 3-dimensional with animals or plants stuffed with crumpled paper or bits of fabric, plants made from twigs or weeds, and other materials such as wood, plastic or rubber that can represent parts of the mural. These murals will make wonderful displays around the school.



RECYCLING SHARE FAIR – ONE PERSON’S TRASH IS ANOTHER’S TREASURE

Direct your students to bring an empty, cleaned item from home that was going to be thrown away (for example, a large plastic soda bottle, an empty powder-detergent box, cardboard packaging, a glass jar, or a plastic container). Provide each student with an index card. Have the child write on one side of the card the name of the item brought in along with a description of its use. Place all the items at the front of the room with their index card explanations. Then have each student select an item that he/she did not bring in. Direct the students to read the index card and then think of a way to create another use for the item. Have a collection of arts-and-crafts supplies on hand for each student to use to re-create the object. Finally, have the students write the name of their new creation and a description of its use on the other side of the card. Set aside time for students to share their recycled creations with their classmates.



DIORAMAS

Divide students into small groups. Each group should prepare a diorama showing something they learned during their O’Neill Sea Odyssey experience. Themes might include food chains, sailing the ocean, habitats, and watersheds. Have them prepare a card or poster of information to go along with their diorama. Have them share their new knowledge with the class or another class in the school!

