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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· 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 zooplankter; 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 phosphorous)
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
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?

A.  
B.  
C.  
D.  
E.  

Answer Key: A. Crab, B. Sea Star, C. Fish, D. Clam, E. Jellyfish
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.  ____________

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

- Primary Producers
  - Diatoms

- 1st Order Consumers
  - Krill and other Zooplankton

- 2nd Order Consumers
  - Fish and Squid

- 3rd Order Consumers
  - Seals

- 4th Order Consumers
  - Killer Whale
Food Chain Pyramid Activity
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
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 (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.

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:

- **Support environmental groups**
- **Take part in beach cleanup days**
- **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
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.

<table>
<thead>
<tr>
<th>ACID RAIN</th>
<th>ADAPTATION</th>
<th>COMMUNITY</th>
<th>CONSERVATION</th>
<th>CONSUMER</th>
<th>DECOMPOSER</th>
<th>DEGRADABLE</th>
<th>ECOLOGY</th>
<th>ECO SYSTEM</th>
<th>ENVIRONMENT</th>
<th>FOOD CHAIN</th>
<th>FOOD WEB</th>
<th>HABITAT</th>
<th>LANDFILL</th>
<th>MARINE ECOLOGIST</th>
<th>PRODUCER</th>
<th>RECYCLING</th>
<th>SANCTUARY</th>
</tr>
</thead>
</table>

- 21 -
** 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**

<table>
<thead>
<tr>
<th>ALGAE</th>
<th>CONSUMER</th>
<th>OCEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALGIN</td>
<td>EAT</td>
<td>PHOTOSYNTHESIS</td>
</tr>
<tr>
<td>BLADDER</td>
<td>FOOD</td>
<td>PIGMENT</td>
</tr>
<tr>
<td>BLADE</td>
<td>FOREST</td>
<td>PLANKTON</td>
</tr>
<tr>
<td>CANOPY</td>
<td>FROND</td>
<td>PRODUCER</td>
</tr>
<tr>
<td>CHAIN</td>
<td>HOLDEAST</td>
<td>SCAVENGER</td>
</tr>
<tr>
<td>CHLOROPHYLL</td>
<td>KELP</td>
<td>STIPE</td>
</tr>
</tbody>
</table>

- 23 -
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 or water (lakes, oceans, and seas).

The water used by the people, plants, and animals living downstream is affected by what happens to the water upstream, 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
**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.
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
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**

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Lion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sailboat</td>
<td></td>
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</tr>
<tr>
<td>Anchor</td>
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<tr>
<td>Life Ring</td>
<td></td>
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</tr>
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<td>Shark</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whale</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DIRECTIONS:**

Locate the latitude and longitude from the center of each picture. Write your answers to the right of each object.
▲ = Public Restroom
❖ = Boaters' Restroom
❖✦ = Boaters' Restroom/Shower
○ = Volleyball Courts
☆ = Catamaran Storage

Mariner Park Way
LAKE AVE
SEABRIGHT AVE

Santa Cruz Yacht Club
Yacht Dry S

Fuel Pier

Launch Ramp

HARBOR OFFICE

Public Restroom

Public Meeting Room

▲✦ and Commercial Fishery

Twin Lakes State Beach

Monterey Bay

Harbor Beach
Catamaran Storage
Volleyball Courts
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 children’s 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 Earth’s __________________________
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

- 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?

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

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?

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, Chardonnay II The Sloop)
2.
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, Gyrocompass, Modern Marine Magnetic Compass)
3.

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 children’s 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: (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: (Possible answers - Exact latitude/longitude, Speed and course of the vessel, Display of appropriate charts, Time, Water temperature, Bearing and waypoints, 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

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? Wood's 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


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


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)


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)


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!
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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 fotosintesis
phytoplankton fitoplancton
plankton  plancton
plankton net red para plancton
primary producer productor primario
salinity  salinidad
Secchi disc disco Secchi
thermometer termómetro
trophic pyramid ---
turbidity turbiedad
water agua
water temperature temperatura del agua
zooplankton zooplancton
ECOLOGY tERmS

(Spanish Translation)

anchovy anchoa
conserve conservar
food chain cadena alementicia
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)
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!