



Under the Sea (Marine Biology)

Grade Levels 3-6

Unit Overview

Materials

- Book: *I Wonder Why the Sea Is Salty: And Other Questions About Oceans* by Anita Ganeri
- Students Journal
- Chart paper
- Rock salt
- Food coloring
- Water
- Globes or maps
- Containers
- Strainers
- White construction paper
- Paint brushes
- Stapler
- Markers/crayons
- Scissors
- Book: *The Earth Is Mostly Ocean* By Allan Fowler
- Seven two-liter bottles
- Labels for bottles
- Graduated cylinders
- Calibrated droppers for 1 ml.
- 5 index cards
- Pictures of mollusks
- Shoe boxes
- Book: *Pagoo* by Holling
- Blue construction paper
- Cotton balls
- Rolling/wiggly eyes
- Computers with Internet access or library resources
- Paper
- Pens/pencils
- Jars
- Pictures of animals on small cards
- Vegetable Shortening
- Gloves
- Alcohol Thermometer
- Bowls
- Ice
- Paper towels

Standards

Unit Content Standards	Unit Youth Development Standards
<ul style="list-style-type: none"> • LA.3.1.6.1: Use new vocabulary that is introduced and taught directly. • LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text. • LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details. • LA.4.1.5.1: Demonstrate the ability to read grade level text. • SC.3.L.15.Pa.a: Match animals that are the same. • SC.3.L.15.Su.a: Sort common animals by observable characteristics. • SCI 1.5.2: Describe the physical characteristics of living things that enable them to live in their environment. 	<p>External Assets:</p> <ul style="list-style-type: none"> • 3 • 5 • 10 • 12 • 14 • 16 • 18 <p>Internal Assets:</p> <ul style="list-style-type: none"> • 21 • 22 • 34 • 35 • 36 • 37

Extension Ideas

- Lesson 3 – students will discover how fresh water floats on top of salt water. Get two jars and fill them 1/2 full with water. Add about 3T of salt to one jar. Stir until the salt is dissolved. Keep adding salt and stirring until no more will dissolve. To the fresh water, add blue food coloring. Pour the fresh water on top of the salt water. You will be able to see the blue water (fresh water) floating on top of the salt water.
- An optional activity for Lesson 4, Mollusks, will be to bring in boxes of shells which students classify into two groups: bivalves and univalves. Try to have an abalone shell because the kids always have a discussion as to how to classify it.
- For Lesson 5 Crustaceans, bring in land hermit crabs. During this part of the unit have hermit crab races.
- Lesson 8 – Divide the class into groups of 3-4 students. Give each group a bucket of sidewalk chalk and take them outside to a hardtop area such as the basketball court, an empty parking lot, etc. Have the students make life sized drawings of whales using the chalk. Have the students stand inside the drawings. Estimate how many people could stand inside the different types of sharks.
- Lesson 9 – visit the website to make your own PowerPoint about stinging cell
<http://www.bioedonline.org/slides/slide01.cfm?tk=2&pg=2>

ELL Modifications

Introduce the lessons through inquiry visuals, vocabulary building strategies, and kinesthetic application.

Pre-Assessment

The students will fill out the first two columns of a K-W-L chart of what they know about marine biology.

Post-Assessment

The students will fill in the last column of their K-W-L chart.

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Lesson 1: Waters of the Earth

Essential Question:

What percent of Earth water is salt water and what percent is fresh water?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
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- LA.4.1.5.1: Demonstrate the ability to read grade level text.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Vocabulary

- Oceans
- Groundwater
- Glaciers
- Water cycle

Teacher Background Knowledge:

- The student will understand the distribution of water on Earth.
- The students will read and discuss The Earth is Mostly Ocean.
- Students will make a striking visual display showing the distribution of water on earth.
- <http://aquacomm.fcla.edu/650/1/Poster13E.pdf>
- <http://www.pbs.org/now/science/unwater.html>

Materials:

Globes or maps

Procedure:

1. Give students pre-assessment (appendix A) – **5 min.**
2. Introduce students to topic and vocabulary – **10 min.**
 - Ask students what they know about Earth waters
 - Have them predict what percent is salt water, fresh water, and unusable fresh water
 - Have the vocabulary words on the board and together with the students write the definition
3. View & discuss video *Oceans Alive: Introduction to Ocean Life* on www.unitedstreaming.com – **10 min.**
4. Whole Group: Read The Earth is Mostly Ocean – **10 min.**
 - Have the students locate the bodies of waters on a globe/map
5. Stem Lab: Waters on Earth (appendix B) – **20 min.**
6. Small Group: students will write in their journal about what they have learned – **5 min.**

Formative Assessment:

- Pre-assessment – This is the assessment given at the beginning and the end of the unit.
- Observation – Teacher should observe listening, writing, reading, discussions, and stem lab activity.
- Student Journal – Students write a paragraph of what they have learned about Earth waters (if time permits have students share with a buddy or class).

Appendix A

NAME: _____

Under the Sea (Marine Biology)

K What I Know	W What I Want to Know	L What I Learned

Appendix B

Stem Lab Activity: Waters on Earth

Procedure:

1. Color about 2 liters of water blue with food coloring.
2. For younger students: have students measure out the volumes, add each amount to a separate bottle.
For older students: have students use these figures to calculate volumes.
Students can fill the bottles and set up a display for the class in a prominent place.



Type of Water	Percentage of Earth's Water Supply	Volume of Water to Use in Bottle
All of the earth's water	100 %	2000 ml
All earth's salt water (oceans)	97.2 %	1944 ml
All earth's fresh water	2.8 %	56 ml
Fresh water locked up as ice	2.3 %	46 ml
Underground fresh water	0.4 %	8 ml
Surface fresh water	~ 0.05 %	1 ml
Water in soil and air	~ 0.01%	0.2 ml

Information from: <http://aquacomm.fcla.edu/650/1/Poster13E.pdf>, Retrieved on June 23, 2009.

Distribution of Earth's Water

Seventy-one percent of the Earth's surface is covered by water. This may cause you to ask, "If there is so much water, why are people so concerned about protecting it?" First, all of the Earth's systems interact, so to keep one part of the Earth healthy, we need to keep all parts healthy. Second, fresh water is essential for all life and it makes up only a small part of all the Earth's water supply.

World's Oceans	Ice Sheets and Glaciers
97.2%	2.15%
Groundwater	Other
.63%	.023%

Of all the Earth's water, only 2.8 percent is fresh, potable water. Of this already small amount, approximately 77 percent is locked in ice sheets and glaciers, and therefore is not readily available for human use. The tiny remaining portion of the Earth's water, .65 percent, is located in lakes and rivers, and underground. This brings us to the main topic of this display. Ninety-seven percent of the world's fresh, usable, water is groundwater.

Information from: <http://www.pbs.org/now/science/unwater.html>, Retrieved June 23, 2009.

Water

There are certain facts about U.S. and international freshwater that everyone should know. According to the World Health Organization, by 2025 the world's population will have increased by 30 percent and access to safe drinking water will be greatly reduced. As water experts remind us, freshwater is a finite resource — there's the same amount of water available now as there was when the earth was formed. See who wins at [wasting water](#).

Over the next two decades it is estimated that the world will need 17% more water to grow food for increasing populations. By 2025, two-thirds of the world's population is likely to live in countries with moderate or severe water shortages.

- While 70% of the Earth's surface is covered by water, 97.5% of the world's water is saltwater and 2.5% freshwater. Most of this freshwater is trapped in polar icecaps, with much of the rest found as soil moisture or kept in underground aquifers.
- According to the World Health Organization, less than 1% of the world's freshwater, or 0.007% of all the water on Earth, is readily available for human world consumption.
- 70% of water withdrawn from freshwater systems goes toward irrigation.
- Out of 191 nations in the world, 10 nations share 65% of the world's annual water resources.
- 1.2 billion people — or almost 1 out of 5 people in the world — are without access to safe drinking water and half of the world's population lacks adequate water purification systems.
- 2.4 billion people, or 40% of the world's population, do not have access to adequate sanitation.
- Agriculture is the largest user of water in developing countries. Agriculture represents about 70 percent of total global freshwater withdrawals. In Africa, the Middle East and South Asia, close to 90 percent of all water withdrawals are for agriculture. In OECD countries, industry accounts for the greatest share of water.

- An estimated 250 million people have been directly affected by desertification — the degradation of dry lands — nearly 1 billion are at risk.
- In developing countries, between 90 and 95 percent of sewage and 70 percent of industrial wastes are dumped untreated into waters where they pollute the usable water supply.

Lesson 2: Oceans of the World

Essential Question:

What are the similarities and differences of the oceans?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.
- LA.4.1.5.1: Demonstrate the ability to read grade level text.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Vocabulary

- Ocean
- Atlantic Ocean
- Pacific Ocean
- Indian Ocean
- Arctic Ocean
- Geography

Teacher Background Knowledge:

- Students demonstrate abilities to research and compare information about oceans.
- Students correctly locate oceans on a world map.
- <http://en.wikipedia.org/wiki/Ocean>

Materials:

A globe or world map, computers with Internet access or library resources, paper, pens/pencils, PowerPoint software (optional)

Procedure:

1. Ask students to name the four oceans. Have students locate the oceans on a globe or world map – **5 min.**
2. Divide the class into six groups. Assign each group two oceans. The ocean pairings are Atlantic-Pacific, Atlantic-Indian, Atlantic-Arctic, Pacific-Indian, Pacific-Arctic, and Indian-Arctic – **30 min.**
 - Tell students that each group will research and write reports about the oceans, noting their similarities and differences.
 - The comparison reports should include information about the oceans' locations, areas, climates, coastlines, natural resources, and elevations.
3. Presentation – each group will present their information – **25 min.**

Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions.
- Each group reports its comparisons to the class.

Lesson 3: Salty Sea

Essential Question:

- What causes the sea to be salty?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.
- LA.4.1.5.1: Demonstrate the ability to read grade level text.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Vocabulary

- Weathering
- Hydrothermal vents
- Submarine volcanoes

Teacher Background Knowledge:

- The student will understand why the sea is salty.
- The students will learn that as rock erodes, rivers carry the salts and other minerals to the ocean.
- The students will learn that the salt in the sea comes from: weathering of continents, hydrothermal vents, and submarine volcanoes.
- <http://www.myuniversalfacts.com/2006/05/why-is-sea-salty.html>
- <http://www.utdallas.edu/~pujana/oceans/why.html>

Materials:

- Book: *I Wonder Why the Sea Is Salty: And Other Questions About Oceans* by Anita Ganeri
- Students journal
- Chart paper
- Rock salt
- Food coloring
- Water
- Containers
- Strainers
- White construction paper
- Paint brushes

Procedure:

1. Introduce students to vocabulary – **5 min.**
2. Write the words and their definition on the board
3. Read the sections from the article *Why is the sea salty* that contain the vocabulary words.
4. Read: *I Wonder Why the Sea Is Salty: and Other Questions about Oceans* by Anita Ganeri – **5 min.**
5. Divide the students in three groups and give each group a chart paper with the questions – **15 min.**
 - *Why is the sea salty?*
 - *Where does the salt come from?*
 - *Is all ocean water salty?*
 - *Which ocean/s is/are the saltiest?*
 - *What affects how salty the ocean is?*
 - *Is the ocean becoming saltier? Why or why not?*
 - *Where would each ocean be least salty?*Each group will write down their responses and share it with the class – **5 min.**
6. Students will return to their group and conduct the salt water activity – **15 min.**
 - Students pour water over the rock salt which is contained in a strainer. The water plus dissolved salt will be collected in a plastic cup. Students will taste the water sample.
 - Students will allow the water to evaporate, observing that the salt remains.
7. Art Activity: Students will do a Saltwater Painting to once again observe the evaporation process – **15 min.**
 - Mix warm water, salt, and food coloring.
 - Paint pictures with the mixture on white paper. Let dry. The water evaporates, but the salt remains, creating beautiful pictures.
8. Assessment – **5 min.**

Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions, throughout the lesson.
- Student Journal – Students will explain/illustrate in their journal why the sea is salty.

Information from: <http://www.myuniversalfacts.com/2006/05/why-is-sea-salty.html>. Retrieved on June 23, 2009.

Why is the Sea Salty?

Published Monday, May 15, 2006

Most of us have been to the beach and know that seawater is salty. But I'm sure the question of why the sea is like this, may have crossed your mind at some point. Lakes (*except for the Great Salt Lake, Dead Sea, Caspian Sea and other salt lakes that have no outlets), ponds and rivers for example are not salty and even the rain that comes from above is fresh water.

Oceans cover about 70% of the earth's surface with water and from this 3 percent is fresh water. Two-thirds of this fresh water is in a solid state (frozen) in glaciers and icecaps. The other 1 percent of this is found in clouds, precipitation (rain and snow), rivers, ponds, lakes and underground water. Seawater has a salinity of 3.5% (35 parts per thousand). In other words, about 35 of 1,000 (3.5%) of the weight of seawater comes from the dissolved salts. This is the amount of salt in the world's oceans. Thus, for every 1 liter of sea water there are 35 grams of salts. Most of the sea's salt is sodium chloride (NaCl)—common table salt—(technically it is called halite) which is dissolved in it.

This dissolved salt is made of two ions; chloride and sodium ions (Na⁺ and Cl⁻). This makes up about 78 percent of the total dissolved chemical substances in seawater. Seawater is a complex solution with trace (smaller) amounts of other chemical elements such as potassium, magnesium, sulfur, and calcium just to name a few. Thus, seawater contains a variety of salts.

Interestingly it may surprise you to know that fresh water, strictly speaking, is not entirely free of dissolved salt. So, rivers, ponds, most lakes and rainwater has some traces of dissolved chemical substances. However the amount is so small (concentration is too low) that it will not be detected by just tasting it. Rainwater picks up traces of dissolved substances during its passage through the atmosphere.

How the Ocean becomes Salty - Why is Seawater salty?

When rain falls, it dissolves carbon dioxide from the surrounding air. This therefore causes the rainwater to be slightly acidic due to carbonic acid. That is, carbonic acid is formed from carbon dioxide dissolving into the rainwater. When this rain water falls to the earth and passes through soil and percolates through rocks, the acid erode the rocks and breaks down the rocks (dissolving some of its minerals) and carries it along its path in a dissolved state as ions. This process is known as weathering. This rainwater with its ions (dissolved minerals/salts) eventually is carried to the streams, rivers, and lakes into the ocean.

The oceans also receive salts (dissolved mineral ions) through submarine volcanism. That is, from the eruption of volcanoes under the oceans floor bed. This process is similar to the rainwater in that it is reacting with hot molten rock and dissolving some of the mineral constituents. Dissolved mineral ions also come from the solid and gaseous materials that escaped from the Earth's crust through volcanic vents above the oceans. This is swept from the land to the ocean by offshore winds, and through runoffs from rainfall that dissolve these minerals. Also, some of the sea's salts come from rocks and sediments dissolved from below its floor. This comes from the ocean floor at places called hydrothermal vents that erode (dissolve) the rocks of the oceanic crust of its constituents (minerals) when it becomes hot thus, adding to the sea's salt content.

This accumulation of dissolved salts left over very long periods of time increases in its concentrations.

The salinity is also increased by evaporation or by freezing of sea ice thus, making it more salty. However, the salinity of the oceans is in a steady state which is due to: many dissolved ions that are used (removed) by marine life, the formation of new minerals at the bottom of the ocean, rainfall, runoff, or the melting of ice which decreases its salinity.

It is worth noting that sea water salinity is not uniform throughout the world. There are sea water located in the eastern sections of Gulf of Finland and in the northern end of Gulf of Bothnia that have seawater with the least salinity compared to other parts of the world. Both these sections are of the Baltic Sea. On the other hand, the most saline open sea is the Red Sea—a long narrow sea between northeast Africa and the Arabian Peninsula. It is linked with the Gulf of Aden and the Arabian Sea by the straits of Bab el Mandeb. The factors responsible for this sea being most saline are caused by confined circulation and high temperatures. Due to the confined circulation, there is little fresh inflow of water from rivers, and along with its high temperature, this causes high rates of surface evaporation. This combines to give the Red Sea a high saline (salty) content in comparison to others.

*Salt lakes such as the Great Salt Lake, Caspian Sea and the Dead Sea are salty (about 10 times saltier than sea water) because they have no outlets like other lakes where water flows in at one end by rivers and streams and out the other end by rivers. This therefore means that all the water that flows into these lakes escapes only by evaporation. So, when this process of evaporation takes place there will be less water content and a higher concentration of salts. Thus, large amounts of dissolved salts remain in the lake.

Information from: <http://www.utdallas.edu/~pujana/oceans/why.html>. Retrieved on June 23, 2009.

WHY IS THE SEA SALTY?

Everyone who has been to the beach knows that seawater is salty. Everyone also knows that fresh water in rain, rivers, and even ice is not salty. Why are some of Earth's waters salty and others not? There are two clues that give us the answer. First, "fresh" water is not entirely free of dissolved salt. Even rainwater has traces of substances dissolved in it that were picked up during passage through the atmosphere. Much of this material that "washes out" of the atmosphere today is pollution, but there are also natural substances present.

As rainwater passes through soil and percolates through rocks, it dissolves some of the minerals, a process called **weathering**. This is the water we drink, and of course, we cannot taste the salt because its concentration is too low. Eventually, this water with its small load of dissolved minerals or salts reaches a stream and flows into lakes and the ocean. The annual addition of dissolved salts by rivers is only a tiny fraction of the total salt in the ocean. The dissolved salts carried by all the world's rivers would equal the salt in the ocean in about 200 to 300 million years.

A second clue to how the sea became salty is the presence of salt lakes such as the Great Salt Lake and the Dead Sea. Both are about 10 times saltier than seawater. Why are these lakes salty while most of the world's lakes are not? Lakes are temporary storage areas for water. Rivers and streams bring water to the lakes, and other rivers carry water out of lakes. Thus, lakes are really only wide depressions in a river channel that have filled with water. Water flows in one end and out the other.

The Great Salt Lake, Dead Sea, and other salt lakes have no outlets. All the water that flows into these lakes escapes only by evaporation. When water evaporates, the dissolved salts are left behind. So a few lakes are salty because rivers carried salts to the lakes, the water in the lakes evaporated and the salts were left behind. After years and years of river inflow and evaporation, the salt content of the lake water built up to the present levels. The same process made the seas salty. Rivers carry dissolved salts to the ocean. Water evaporates from the oceans to fall again as rain and to feed the rivers, but the salts remain in the ocean. Because of the huge volume of the oceans, hundreds of millions of years of river input were required for the salt content to build to its present level.

Rivers are not the only source of dissolved salts. About twenty years ago, features on the crest of oceanic ridges were discovered that modified our view on how the sea became salty. These features, known as **hydrothermal vents**, represent places on the ocean floor where sea water that has seeped into the rocks of the oceanic crust, has become hotter, and has dissolved some of the minerals from the crust, now flows back into the ocean. With the hot water comes a large complement of dissolved minerals. Estimates of the amount of hydrothermal fluids now flowing from these vents indicate that the entire volume of the oceans could seep through the oceanic crust in about 10 million years. Thus, this process has a very important effect on salinity. The reactions between seawater and oceanic basalt, the rock of ocean crust, are not one-way, however; some of the dissolved salts react with the rock and are removed from the water.

A final process that provides salts to the oceans is submarine volcanism, the eruption of volcanoes under water. This is similar to the previous process in that seawater is reacting with hot rock and dissolving some of the mineral constituents.

Will the oceans continue to become saltier? Not likely. In fact the sea has had about the same salt content for many hundred of millions if not billions of years. The salt content has reached a **steady state**. Dissolved salts are being removed from seawater to form new minerals at the bottom of the ocean as fast as rivers and hydrothermal processes are providing new salts.

We can summarize this discussion. Wherever water comes into contact with the rocks of Earth's crust, either on land or in the ocean or within the oceanic crust, some of the minerals in the rock dissolve and are carried by the water to the ocean. The salt content of seawater does not change because new minerals are forming on the sea floor at the same rate as salt is added. Thus, the salt content of the sea is at steady state.

THE SALTS IN THE SEA COME FROM:

- > WEATHERING OF CONTINENTS
- > HYDROTHERMAL VENTS
- > SUBMARINE VOLCANOES

Lesson 4: The World of Fish

Essential Question:

What are the three major groups to which fish belong?

Content Standards: 3rd, 4th, 5th, & 6th

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- SC.3.L.15.Pa.a: Match animals that are the same.
- SC.3.L.15.Su.a: Sort common animals by observable characteristics.

Youth Development Standards:

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- 3
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- 16
- 18

Internal Assets:

- 21
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- 34
- 35
- 36
- 37

Vocabulary

- Agnathas
- Chondrichthyes
- Osteichthyes

Teacher Background Knowledge:

- The student will be able to classify fish into three categories.
- <http://www.historyoftheuniverse.com/jawlfish.html>
- <http://simple.wikipedia.org/wiki/Chondrichthyes>
- <http://www.fernbank.edu/stt/VertBio/pages/Osteichthyes/osteichthyes.htm>

Materials:

The major groups of fish worksheet for every student, copy of the fish mini book for each student, students journal, what is a fish poster, white bulletin board paper, markers/crayons, scissors, glue, pencil, stapler

Procedure:

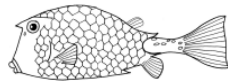
1. Start the lesson by asking the students: *What is a fish?* – **5 min.**
 - Write their response on the board of chart paper
 - Have a large copy (or several copies) of the What is a Fish poster
 - Chorally read the poster and discuss
2. Vocabulary words and PowerPoint – **15 min.**
 - Have the vocabulary words on the board or on index cards and introduce the words one at a time along with the PowerPoint
 - At the end of the PowerPoint have the students write the definition of each word
3. Mini-book – **5 min.**
 - Give each student a copy of the mini-book
 - Have them read the mini-book with a buddy
4. Art Activity/Writing: Fashion a Fish (Appendix A) – **25 min.**
 - Students will become marine biologists
 - See Appendix A for instruction
 - At the end of the activity the students will write in their journal a description of their fish using the information in Appendix B as a guide
5. Assessment: Major Groups of Fish – **10 min.**

Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions, throughout the lesson.
 - Give each student a copy of the Major Groups of fish worksheet
 - The students will cut out all the pictures and glue them in the correct category: Jawless Fish, Bony Fish, Cartilaginous

Appendix A

Fashion a Fish



In this activity you will be marine biologists who have discovered a new species of fish. Think about what you have learned about fish adaptations such as body shapes, mouth shapes, coloration, camouflage, and defense mechanisms.

Materials:

Large sheet of white bulletin board paper, markers, scissors, glue, pencil, stapler

Instructions:

1. Draw a large picture of your fish on a large sheet of folded paper.
2. Draw the pectoral and pelvic fins on a separate piece of paper.
3. Trace the drawing with a permanent black marker.
4. Turn the paper over and trace the drawing on the other side.
5. Color both sides of the paper and keeping the paper folded, cut it out.
6. Staple the two sides together leaving an opening.
7. Stuff the fish with crumpled paper to give it a three-dimensional look and staple it closed.
8. Glue on the pectoral and pelvic fins.
9. Write a description of your fish. Be creative. You may write your description in the form of a newspaper article, an interview or a scientific journal report. Your information may be hand written or typed.

Appendix B

Fashion a Fish



Think about the following information when creating your drawing and written description:

Name of your fish - _____

type of fish - agnatha, chondrichthyes (cartilaginous fish), osteichthyes (bony fish) _____

habitat - where does your fish live in the ocean? (coral reef, kelp forest, abyss) _____

migration - does your fish migrate or live its entire life in one region? _____

location in the world - what ocean(s) does your fish live in? _____

coloration/camouflage, defense adaptations - _____

how they swim/move/anchor - _____

physical features - body shape, type of fins and # of fins, scales, size, mouth position, eye position, nostril position, barbels, etc. _____

predators/prey - what does your fish eat and what eats your fish? _____

Information from: <http://www.historyoftheuniverse.com/jawlfish.html>. Retrieved on June 23, 2009.

Fish without jaws were the first vertebrates. Just like the mollusks and arthropods, the early fish had a hard outer covering. This armor plating around their front ends was made of bone. Perhaps it was a defense against sea scorpions. They first appeared around 500 million years ago, during the Ordovician period as small fish-like animals called **ostracoderms**.

They probably ate by sucking in mud through their mouths. They filtered out particles of food as the water left through their gills. Jaws appeared later, and so did paired fins which were used for swimming. Some had two fins, some four or more. Many of them had flattened bodies, and were probably not very agile.

Early fish contained a swim bladder -- a bag of air to help them float. The strong bone casing around the head allowed the brain, eyes and other senses to develop.

Some jawless fish still survive today. They are the lampreys and hagfish.

Information from: <http://simple.wikipedia.org/wiki/Chondrichthyes>. Retrieved on June 23, 2009.

Chondrichthyes

From Wikipedia, the free encyclopedia

Chondrichthyes or **cartilaginous fishes** are jawed fish with paired fins, paired nostrils, scales, two-chambered hearts, and skeletons made of cartilage rather than bone. They are divided into two subclasses: Elasmobranchii (sharks, rays and skates) and Holocephali (chimaera, sometimes called ghost sharks).

Taxonomy

- Class **Chondrichthyes**
 - Subclass Elasmobranchii (sharks, rays and skates)
 - Superorder Batoidea (rays and skates), containing the orders:
 1. Rajiformes (common rays and skates)
 2. Pristiformes (Sawfishes)
 3. Torpediniformes (electric rays)
 - Superorder Selachimorpha (sharks), containing the orders:
 1. Hexanchiformes: Two families are found within this order. Species of this order are distinguished from other sharks by having additional gill slits (either six or seven). Examples from this group include the cow sharks, frilled shark and even a shark that looks on first inspection to be a marine snake.

2. Squaliformes Three families and more than 80 species are found within this order. These sharks have two dorsal fins, often with spines, and no anal fin. They have teeth designed for cutting in both the upper and lower jaws. Examples from this group include the bramble sharks, dogfish and roughsharks.
3. Pristiophoriformes One family is found within this order. These are the *sawsharks*, with an elongate, toothed snout that they use for slashing the fishes that they then eat.
4. Squatiniformes One family is found within this order. These are flattened sharks that can be distinguished from the similar appearing skates and rays by the fact that they have the gill slits along the side of the head like all other sharks. They have a caudal fin (tail) with the lower lobe being much longer in length than the upper, and are commonly referred to as *angel sharks*.
5. Heterodontiformes One family is found within this order. They are commonly referred to as the *bullhead*, or *horn sharks*. They have a variety of teeth allowing them to grasp and then crush shellfishes.
6. Orectolobiformes Seven families are found within this order. They are commonly referred to as the *carpet sharks*, including zebra sharks, nurse sharks, wobbegongs and the largest of all fishes, the whale sharks. They are distinguished by having barbels at the edge of the nostrils. Most, but not all are nocturnal.
7. Carcharhiniformes Eight families are found within this order. It is the largest order, containing almost 200 species. They are commonly referred to as the *groundsharks*, and some of the species include the blue, tiger, bull, reef and oceanic whitetip sharks (collectively called the requiem sharks) along with the houndsharks, catsharks and hammerhead sharks. They are distinguished by an elongated snout and a nictitating membrane which protects the eyes during an attack.
8. Lamniformes Seven families are found within this order. They are commonly referred to as the *mackerel sharks*. They include the goblin shark, basking shark, megamouth, the thresher, mako shark and great white shark. They are distinguished by their large jaws and ovoviviparous reproduction. The Lamniformes contains the extinct Megalodon (*Carcharodon megalodon*), which like most extinct sharks is only known by the teeth (the only bone found in these cartilaginous fishes, and therefore are often the only fossils produced). A reproduction of the jaw was based on some of the largest teeth (up to almost 7 inches in length) and suggested a fish that could grow 120 feet in length. The jaw was realized to be inaccurate, and estimates revised downwards to around 50 feet.

Information from: <http://www.fernbank.edu/stt/VertBio/pages/Osteichthyes/osteichthyes.htm>.

Retrieved on June 23, 2009.

Osteichthyes

Class Osteichthyes (the bony fish) is the largest class of vertebrates with over 20,000 species. The total numbers of fishes exceed that of all other kinds of vertebrates combined. This is not surprising considering four fifths of the earth's surface is covered with water. Bony fish have a skeleton much

stiffer than the cartilaginous fish because it is reinforced by calcium salts. Bony fish have excellent smell like cartilaginous fish, but unlike the other class of fish, bony fish also have acute eyesight.

Bony fish also have special adaptations that allow them to remain buoyant. A special organ called a swim bladder housed under the bony skeleton is a gas filled chamber that allows the bony fish to remain floating in the water. Another special adaptation is the operculum, a bone on each side of the fish that covers the chambers housing the gills. A bony fish is able to breathe without swimming simply by moving the operculum. Other hallmarks of these fish are paired fins, many teeth, dermal scales in the skin (in most species), and numerous vertebrae. Most bony fish are ray-finned fish, meaning that they have thin, flexible skeletal rays.

Lesson 5: Mollusks

Essential Question:

What are the characteristics of mollusks?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.

Youth Development Standards:

External Assets

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Vocabulary

- Mollusks
- Univalves
- Bivalves
- Cephalopods

Teacher Background Knowledge:

- The student will understand what are mollusks
- <http://www.seasky.org/reeflife/sea2f.html>
- <http://www.oceaninn.com/guides/mollusks.htm>

Materials:

- 5 index cards, cut out pictures of mollusks

Procedure:

1. Start the lesson by reading and discussing with the class: A Beginner's Introduction to Mollusks by Sammy Snail (Appendix A) – **5 min.**
2. Show the PowerPoint to introduce the vocabulary words – **10 min.**
3. Watch the video *Mollusks* on www.unitedstreaming.com – **10 min.**
4. Physical Activity: eight-legged octopus race – **20 min.**
 - Have four students stand back to back and link arms to make an eight legged octopus.
 - Have each “octopus” race other “octopuses” to see who is the fastest “octopus.”

Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions, throughout the lesson.
- Find Your Match (Appendix B)
 - On the index cards write the words: Gastropods, Bivalves, Cephalopods, Scaphopoda, Polyplacophora
 - Pass out the cards and the pictures randomly to students
 - Explain to them that they are to move around the room to find their match/group
 - For example: the student that has the word bivalves will end up in the group with the students that have the pictures of scallop, clam and mussel
 - Once they found their match they can share with each other what they learn about mollusks

Appendix C

A Beginner's Introduction to Mollusks by Sammy Snail



Hello, my name is Sammy Snail and I am a mollusc.

The name "mollusc" is derived from the **Latin** word "*mollis*" which means soft. (Latin is the language scientists use to talk about things in nature.) My body is soft. I do not have a backbone, or any other bones for that matter. My skeleton is in fact my shell - and some of my cousins don't even have a shell! Scientists classify me as an **invertebrate**, which is just a big name for a group of animals without backbones.

Scientists who study molluscs are called **conchologists** or **malacologists**. Scientists group all plants and animals into specific categories according to their common body features. These features may include such things as where they live, what they eat and how their bodies are made and work. Conchologists grouped us molluscs together because of the following **common features we share**.

1. Like me, most of my relatives have a **shell**. This is a hard home that we build to house and protect our soft bodies. Not all of us have a shell though.
2. We all have a fleshy **mantle**. This is a flesh-like lobe or pair of lobes that produce our shell
3. We have a **radula**. This is our teeth. Our radula resembles a fingernail file or the chain on a chain saw. We rasp our food with this rough ribbon of teeth just like a cat licks up his food with his rough tongue. Our radula is located in our mouth just like your teeth are in your mouth. (Billy Bivalve and his relatives the bivalves don't have this radula. Billy will tell you about his family a little later.)
4. We all have a muscular **foot**. We use our foot to move around on or some use it to dig into the sand or mud where they live. Some of our relatives use this foot to cling onto hard rocky surfaces. They can hang on so tightly, that you cannot pull them off. In some of our other relatives, like the squid and octopus, their foot has evolved (changed over thousands of years) to become many arms or tentacles.
5. We all have to keep our **soft bodies moist** to stay alive

My mollusc relatives have learned to survive in almost all the areas of the world. The **aquatic molluscs** live in water. They live in the **salty oceans** from the intertidal areas (that area where waves and tides wash in and out) to the deepest parts, called trenches. Many live in **fresh water** areas such as lakes and streams. The **terrestrial molluscs** live on **land**. This is where my closest relatives and I live. **(Maybe you have seen one of my cousins in your own back yard.)** Some, like me, live under rotting leaves or logs. Others live high up in the trees. Some live on mountains, others in deserts. So you see, we have adapted rather well to living here on earth.

Some of my mollusc relatives have even **evolved to become molluscs without a shell**. They too, live in the oceans and on land. You may know some of these shells land cousins of mine as the **slugs** and the ones living in the oceans as **sea butterflies** or **sea slugs** (they are very beautiful: for many pictures of these lovely creatures, see the [Flat Worms of the World](#) site - the best photos start about 1/3 down the page.)

Scientists have taken our large group (known as a **Phylum**), **the molluscs**, and have divided us into **seven classes**. Molluscs within each **Class** have body features that are similar to each other. This class is then further divided into families once again according to their similarities.

Appendix D

Can You Find Your Match

Gastropods

1. Tritons trumpet
2. Nudibranch
3. Land snail
4. Cowrie

Bivalves

5. Scallop
6. Clam
7. Mussel

Cephalopods

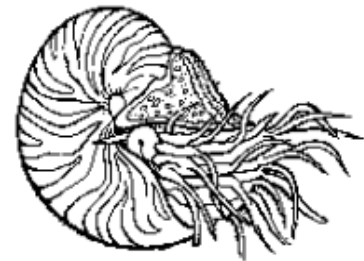
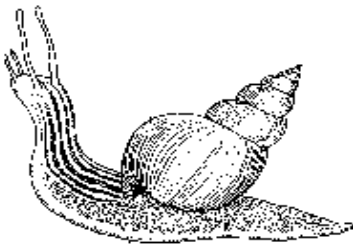
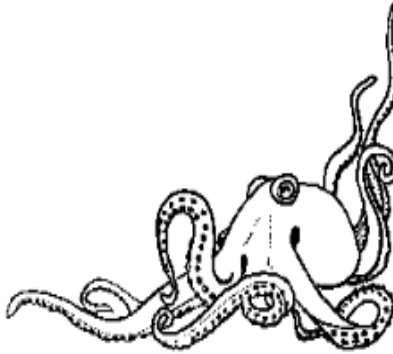
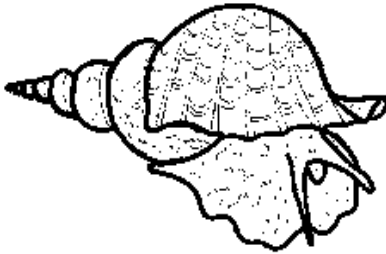
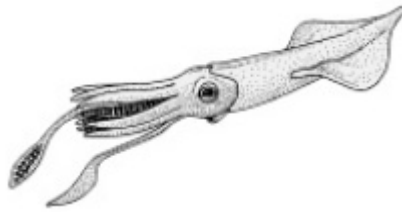
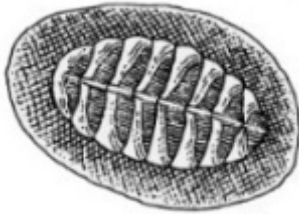
8. Octopus
9. Squid
10. Chambered nautilus

Scaphopoda

11. Tusk Shell

Polyplacophora

12. Chiton



Answer Key

Can You Identify These Molluscs

Name: _____

Gastropods

- 1. Tritons trumpet
- 2. Nudibranch
- 3. Land snail
- 4. Cowrie

Bivalves

- 5. Scallop
- 6. Clam
- 7. Mussel

Cephalopods

- 8. Octopus
- 9. Squid
- 10. Chambered nautilus

Scaphopoda

- 11. Tusk Shell

Polyplocophera

- 12. Chiton



12.



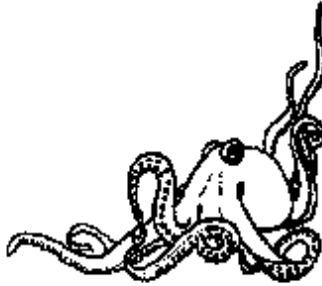
9.



7.



1.



8.



5.



2.



4.



11.



3.



6.



10.

Information from: <http://www.seasky.org/reeflife/sea2f.html>. Retrieved on June 24, 2009.

Mollusks

Mollusks comprise a group of soft-bodied animals that includes snails, clams, and sea slugs. The most common characteristic of most mollusks is their shell. One of the largest groups, the snails, is renowned for their shells. Snails are univalves, which means they have one shell. And it is this shell that for many people is the epitome of the ocean. There is perhaps no other ocean treasure that displays more diversity and beauty than the shell. Conchology, the study and collection of shells is a popular hobby the world over. The bivalves, or two-shell mollusks include the clams, scallops, and oysters. It is the oyster that is responsible for producing the most coveted of the ocean's treasures - the pearl. Still other mollusks have lost their shells altogether. The octopus, the squid, and the sea slugs have evolved their own survival strategies to replace their protective armor. Indeed, it is due to the absence of a protective shell the octopus has evolved the largest and most complex brain of all the mollusks. Below is a listing of some of the most common mollusks found on the world's coral reefs.

Information from: <http://www.oceaninn.com/guides/mollusks.htm>. Retrieved on June 24, 2009.

Oceanside Meadows Institute for the Arts and Sciences presents: Wonders of the Sea: Mollusks

The phylum Mollusca is the largest and most diverse phylum of animals next to arthropods. Mollusks can be found in nearly every ecosystem on earth, from high, barren mountains to grassy plains, lakes, rivers and in all seas and oceans. There are nearly 100,000 species of mollusks identified today, with new species being encountered and named every year as new discoveries are made in ocean depths and tropical rainforests.

The body of a mollusk is generally composed of the shell and the fleshy, living part. The fleshy parts of a mollusk can be further divided into the foot and the visceral mass. The foot is a distinctive molluscan feature, adapted in a variety of ways for locomotion. The visceral mass includes the organs for digestion, circulation, reproduction, and respiration. The visceral mass also includes two external flaps of tissue called the mantle, which secretes the calcareous shell and encloses a mantle cavity. The fluid in the mantle cavity, which in aquatic mollusks is continually replaced with water from the outside, carries away excess water, ions and wastes, and helps circulate nutrients and oxygen. Another structure unique to mollusks, found in most groups except bivalves and a few others is the radula. In most forms the radula is a rasping organ near the mouth variously modified for special feeding techniques.

These two structures - the mantle and radula - are found in Mollusca and nowhere else in the animal kingdom.

Classification

Most taxonomists now recognize eight classes of mollusks, based mainly on differences in the foot and shell. These differences are usually quite apparent, making it easy to identify on sight the class to which a mollusk belongs. Only the following four main classes will be discussed in this guide:

*** Gastropoda:**

This largest and most successful class of mollusks contains 35,000 living species including snails, periwinkles, conches, whelks, limpets and sea slugs.

*** Bivalvia:**

Members of this class such as clams, cockles, mussels, oysters and scallops, are an important food source for humans as well as for gastropods, fish, and shore birds.

*** Cephalopoda:**

The most highly organized group of mollusks includes squids, octopuses, cuttlefish, and nautilus.

*** Polyplacophora:**

Members of this class are commonly referred to as chitons. These rock-clinging marine mollusks are abundant on rocky coasts throughout most of the world.

Interaction with humans and other animals

Mollusks are important to humans as well as other animals as food. Some shells are a major source of calcium for some birds. The consumption of mollusks goes back centuries. Indeed, humans found a way to use oysters to increase the food supply indirectly: The crushed shells attract micro-organisms that kill the nematodes that are agricultural pests. Mollusks also nourish humans culturally. Rare and beautiful shells have been prized throughout history and many are still extremely valuable to collectors. In some early cultures mollusk shells served as money. Humans are undoubtedly more harmful to mollusks than the reverse.

Because bivalves are filter feeders, they tend to accumulate pollutants and in many places they are collected and analyzed as a means for monitoring water pollution.

Pollution effects on bivalve mollusks are particularly apparent in coastal waters, though ocean dumping can contaminate offshore stalks as well. Coastal pollution has in recent decades become a significant and growing problem, calling for greater understanding of the effects of man's activities on habitats and increased awareness of this aspect of environmental degradation.

Conchs, Slugs, and Snails: Class Gastropoda

More than one third of all mollusk species are gastropods. This largest molluscan class includes a diversity of forms that can be divided into three subclasses: Prosobranchia, Opisthobranchia and Pulmonata.

Most gastropods have a single spiral shell, but many are shell-less. The fleshy body of gastropods has clearly defined regions: head, foot, mantle and visceral mass. The head includes sense organs (tentacles and eyes) and a mouth that is armed with a radula and sometimes jaws. The mantle often includes the tubular respiratory siphon. But there are deviations from all these standard features, since gastropods

have undergone a certain amount of evolutionary experimentation. One of the peculiarities of gastropod organization is the way the digestive tract doubles back on itself, with the mouth and anus at the same end. This is due to torsion, one of the few features found in all living gastropods and in no other group.

Clams, Mussels, and Oysters: Class Bivalvia

The distinctive members of the class Bivalvia are not likely to be confused with any other marine animals. They include the familiar clams, mussels, oysters and other animals with shells consisting of two laterally poised symmetrical valves. Normally the valves are held open by an elastic ligament near the hinge; when threatened the bivalve can clam up using its adductor muscles. The soft body of a bivalve consists of a visceral mass, a hatchet shaped foot, sided by a pair of gills and a mantle lobe next to each shell that secrete the shell. The foot is a distinctive feature of a bivalve, located toward the front of the body. Usually they are fused below to enclose a mantle cavity, leaving an opening for the foot. The foot is located toward the front of the body. The foot is well developed in clams and other strong burrowers but almost non-existent in scallops and oysters. The rear part of the bivalve is defined by a pair of tubes or siphons. One of these siphons carries water in while the other pumps water out; in the process, the bivalve receives oxygen and food items and eliminates wastes. Bivalves are thus filter feeders.

Squids, Cuttlefish and Octopuses: Class Cephalopoda

Members of the class Cephalopoda are among the most highly evolved invertebrates. Unlike most mollusks, cephalopods have a closed circulatory system capable of sustaining high metabolic levels. They are active, fast moving and seemingly intelligent. Cephalopods are named for the foot, which is integrated into the head in the form of arms, tentacles or a funnel. They expel water through the funnel for locomotion, and they use their tentacles and arms mainly during predation. When the animal is threatened, an ink sac ejects its contents through the siphon, providing a smoke screen for escape.

Cephalopods are divided into two quite different subclasses that differ in the number and form of the tentacles. Subclass Coleoidea comprises squid, cuttlefish and octopuses, all of which have eight arms with suckers lining the inner surfaces.

Cephalopods have a phenomenal ability to change color, and they do so according to mood and the need for camouflage. Out of water, squids are soft and flaccid, a sorry transformation from their grace and alertness in the water.

Chitons: Class Polyplacophora

Members of class Polyplacophora are commonly referred to as chitons, because of their dorsal shells consisting of eight overlapping plates. Chitons clamp themselves tightly to rocks and pilings by a wide sole-shaped foot from which it is very difficult to dislodge them undamaged. Chitons possess a head of primitive type which has neither tentacles nor eyes. The foot is flat and motion is achieved by waves of contraction passing forward. The Polyplacophora show bilateral symmetry. The mouth and anus lie at opposite ends of the body, the visceral mass in between, covered by a girdle loaded with spicules that unite to form plate-like valves.

Lesson 6: Crustaceans

Essential Question:

What animals are members of the crustacean family?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.
- SCI 1.5.2: Describe the physical characteristics of living things that enable them to live in their environment.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Teacher Background Knowledge:

- The student will understand what are mollusks
- <http://www.seasky.org/reeflife/sea2e.html>
- <http://www.junglewalk.com/info/Crustacean-information.htm>
- <http://insected.arizona.edu/arthroinfo.htm>

Vocabulary

- Crustaceans
- *Exoskeleton*
- Invertebrates

Materials:

- Student journal, book *Pagoo* by Holling, stapler, blue construction paper, 3 cotton balls for each student, rolling/wiggly eyes

Procedure:

1. Start the class by viewing the video Three Features of Phylum Arthropoda: Exoskeleton, Segmented Body, and Jointed App from www.unitedstreaming.com – **3 min.**
2. After the video introduce the students to Phylum Arthropods by interacting with them and asking them to respond to a number of open-ended questions about arthropods – **10 min.**
 - What are arthropods? Who can give some examples of arthropods?
 - Where do we find arthropods?
 - How do we classify arthropods? What is the most familiar group of arthropods?
 - Describe some basic characteristics shared by all arthropods.
3. Introduce the vocabulary words – **10 min.**
 - Have the words on the board
 - Divide the class in groups of 3 or 4
 - Have the students come up with the definition of each word from the information that they have gathered from the video and class discussion
 - Go over the vocabulary words together
4. Explain to the students that we will be focusing on Crustaceans
 - Read the paragraph on crustacean from <http://www.seasky.org/reeflife/sea2f.html>
5. Read and discuss the book *Pagoo* by Holling – **15 min.**
 - Student will discuss with a buddy the life of a Hermit crab
6. Art Activity: Diagram of a blue crab – **10 min.**
 - Students will use blue construction paper to draw a diagram which includes the back and front views
 - They will stuff it with three cotton balls and staple it together
 - On the top they will glue rolling eyes
7. Assessment – **10 min.**

Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions, throughout the lesson.
- Student Journal – students will write facts about Crustaceans.

Information from: <http://www.seasky.org/reeflife/sea2f.html>. Retrieved on June 24, 2009.

Crustaceans

The world of the crustaceans is a world of bizarre shapes and adaptations. This group of animals is probably best known for their hard outer shell. As the animal grows, this shell must be removed and discarded. Once this takes place, the new shell takes time to harden. During this period, the animal is without its primary means of protection and vulnerable to attack from predators. But they have an impressive arsenal of weapons at their disposal. The claw of many crustaceans is capable of exerting hundreds of pounds of pressure. Some even have the unique ability to produce a deafening miniature sonic boom with which they stun their prey. The mantis shrimp can even break the glass of an aquarium or split a man's thumb to the bone with one strike. But in spite of their impressive armor and fierce weaponry, the crustaceans do occasionally meet their match. The teeth of the triggerfish and the beak of the octopus can crack through the toughest shells of crabs and lobsters, making an enjoyable meal. Below is a listing of some of the more common crustaceans to be found on the coral reef.

Information from: <http://www.junglewalk.com/info/Crustacean-information.htm>. Retrieved on June 24, 2009.

More About Crustaceans

The crustaceans (Crustacea) are a large group of arthropods (55,000 species), usually treated as a subphylum. They include various familiar animals, such as lobsters, crabs, shrimp and barnacles. They are variously found in marine and freshwater, with a few terrestrial members (such as woodlice).

Crustaceans have 3 distinct body parts: head, thorax, and abdomen. They have two pairs of antennae on the head, compound eyes, three pairs of mouthparts and a telson. Smaller crustaceans respire through their body surface by diffusion and larger crustaceans respire with gills. Crustaceans typically have a thick carapace on the dorsal side of their body. Their appendages are typically biramous, including the second pair of antennae (but not the first).

Most crustaceans have separate sexes and are distinguished by appendages on the abdomen called swimmerets. The first (and sometimes the second) pair of swimmerets are larger on the male than on the female. Terrestrial crabs mate seasonally and return to the sea to breed. Female crabs' eggs are retained by the females until they hatch. The eggs hatch into free-swimming larvae.

Although crustaceans are rarer as fossils than trilobites are, a number of different types of crustaceans are common in the rocks of the Cretaceous period as well as those of the Cenozoic era. Most of the smaller crustaceans, such as shrimp, have an exoskeleton which is somewhat delicate and for this reason their fossil record is incomplete. However, crustaceans such as crabs and lobsters have a thicker exoskeleton which is reinforced with calcium carbonate and so their fossil record is much better. The fossil record of barnacles is scarce and little is known of their history prior to the Mesozoic era. Well preserved specimens are known from the rocks of the Cretaceous period and the Cenozoic era.

The most well known crustaceans, the malacostraca (crabs, lobsters, crayfish, shrimp), although

widespread today are only found sporadically as fossils. Most of the known fossil crabs are of forms which lived on the sea-floor or in a reef environment. In rocks such as the Gault clay from the Cretaceous period and the London clay from the Eocene period in England fossil crabs may be found. The 'Lobster Bed' of the Greensand formation from the Cretaceous period which occurs at Atherfield on the Isle of Wight in England contains many well preserved examples of the small lobster *Mecochirus magna*. The lithographic limestones from the Jurassic period of Solnhofen in Germany have long been famed for the many exceptionally preserved crabs, lobsters and shrimp fossils they have yielded (such as *Aeger*, *Eryon*, and *Pseudastacus*).

Source: Wikipedia

Information from: <http://insected.arizona.edu/arthroinfo.htm>. Retrieved on June 25, 2009.

Arthropod Information

What is an arthropod?

The arthropods constitute over 90% of the animal kingdom and are classified in the phylum Arthropoda. They are distinguished from other animals by:

- an exoskeleton (a skeleton on the outside of the body)
- body divided into distinct parts
- jointed legs and appendages
- bilateral symmetry (both sides of the body are the same)

Class Distinctions

Insects

Grasshoppers, butterflies, beetles, ants, etc. 1,000,000 described world species

- three body regions: head, thorax, abdomen
- six legs attached to the thorax (which has 3 segments)
- adults with one or two pairs of wings attached to the thorax (some have none)
- two antennae
- lateral compound eyes



Arachnids

Spiders, scorpions, ticks, mites, etc. 65,000 described world species

- two body regions: cephalothorax, abdomen
- eight legs
- no antennae
- Mouth parts are chelicerae(modified appendages) which in spiders are fangs



Crustaceans (technically a subphylum)

Classes include crabs, shrimps, lobsters, barnacles, isopods etc. 44,000 described world species

- two body regions
- two pairs of antennae
- 5 or more pairs of legs
- primarily aquatic, few terrestrial



Chilopods

Centipedes. 2,800 described world species

- well-defined head
- first pair of legs modified for envenomation
- flattened top to bottom
- one pair of legs per segment
- one pair of antennae



Diplopods

Millipedes. 10,000 described world species

- two pairs of legs per segments, first four segments have 1 pair legs
- one pair of antennae
- well-defined head
- usually cylindrical



Lesson 7: Echinoderms

Essential Question:

What are the five classes of echinoderms?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.
- LA.4.1.5.1: Demonstrate the ability to read grade level text.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Teacher Background Knowledge:

- <http://www.starfish.ch/reef/echinoderms.html>
- <http://www.mcwdn.org/Animals/Starfish.html>
- <http://www.oceanicresearch.org/education/wonders/echinoderm.html>
- <http://www.junglewalk.com/info/echinoderm-information.htm>

Vocabulary

- Echinoderms
- Regeneration
- Autonomy
- Fission

Materials:

- Specimens of sea cucumbers, sea urchins, sea biscuits, sand dollars, and starfish; agfa loupes/ magnifying glasses; chart paper

Procedure:

Note: Before the lesson begins please visit the website <http://www.starfish.ch/reef/echinoderms.html> So that you can copy some of the pictures and information on a PowerPoint to show to the students as you present the five classes of echinoderms.

1. As you present the categories of echinoderms one at a time have pictures on the board for students to see. At the same time you will be introducing the vocabulary words as you come along – **20 min.**
2. **Stem Lab – Echinoderms Specimens – 25 min.**
 - Look at specimens of sea cucumbers, sea urchins, sea biscuits, sand dollars, and starfish to see the similarities.
 - Use agfa loupes or magnifying glasses to examine the specimens.
 - Have each child take a different echinoderm and draw what they see under the loupe.
 - Do not have them draw the entire animal, only a part.
 - Everyone in the class tries to guess what their drawing is of.
3. Assessment – **10 min.**

Formative Assessment:

- Observation – Teacher should observe listening, writing, discussions, art work.
- Gallery Walk
 - Have 5 chart paper posted around the room each one with a different heading:
 - Characteristics of sea stars (or starfish)
 - Characteristics of feather stars
 - Characteristics of brittle stars
 - Characteristics of sea urchins
 - Characteristics of sea cucumbers
 - Divide the class in five groups
 - Give each group a different color marker
 - They will circulate around the room to each chart paper adding information to the chart

ECHINODERMS

(Echinodermata)

Characteristics of Echinoderms

Echinoderms are characterized by radial symmetry, several arms (5 or more, mostly grouped 2 left - 1 middle - 2 right) radiating from a central body (= pentamerous). The body actually consists of five equal segments, each containing a duplicate set of various internal organs. They have no heart, brain, nor eyes, but some brittle stars seem to have light sensitive parts on their arms. Their mouth is situated on the underside and their anus on top (except feather stars, sea cucumbers and some urchins).

Echinoderms have tentacle-like structures called tube feet with suction pads situated at their extremities. These tube feet are hydraulically controlled by a remarkable vascular system. This system supplies water through canals of small muscular tubes to the tube feet (= ambulacral feet). As the tube feet press against a moving object, water is withdrawn from them, resulting in a suction effect. When water returns to the canals, suction is released. The resulting locomotion is generally very slow.

Ecology and range of Echinoderms

Echinoderms are exclusively marine. They occur in various habitats from the intertidal zone down to the bottom of the deep sea trenches and from sand to rubble to coral reefs and in cold and tropical seas.

Behavior of Echinoderms

Some echinoderms are carnivorous (for example starfish) others are detritus foragers (for example some sea cucumbers) or planktonic feeders (for example basket stars).

Reproduction is carried out by the release of sperm and eggs into the water. Most species produce pelagic (= free floating) planktonic larvae which feed on plankton. These larvae are bilaterally symmetrical, unlike their parents (illustration of larvae of a sea star below). When they settle to the bottom they change to the typical echinoderm features.

Echinoderms can regenerate missing limbs, arms, spines - even intestines (for example sea cucumbers). Some brittle stars and sea stars can reproduce asexually by breaking a ray or arm or by deliberately splitting the body in half. Each half then becomes a whole new animal.

Echinoderms are protected through their spiny skins and spines. But they are still preyed upon by shells (like the triton shell), some fish (like the trigger fish), crabs and shrimps and by other echinoderms like starfish which are carnivorous. Many echinoderms only show themselves at night (= nocturnal), therefore reducing the threat from the day time predators.

Echinoderms serve as hosts to a large variety of symbiotic organisms including shrimps, crabs, worms, snails and even fishes.

Sea stars (starfish)
(Asteroidea)

Characteristics of sea stars (or starfish)

Sea stars are characterized by radial symmetry, several arms (5 or multiplied by 5) radiating from a central body. Mouth and anus are close together on the underside, the anus is at the center of the disc together with the water intake (madreporite). The upper surface is often very colorful. Minute pincer-like structures called pedicellaria are present. These structures ensure that the surface of the arms stay free from algae. The underside is often a lighter color.

There are a few starfish that have 6 or 7 arms, for example Echinaster luzonicus or Protoreaster, some even more like the eleven-armed sea star (Coscinasterias calamaria). Others normally have 5 arms but now have more arms, because after an injury an arm divided and grew into two arms.

Ecology and range of sea stars

The starfish lives everywhere in the coral reef and on sand or rocks.

Behavior of sea stars

The majority of sea stars are carnivorous and feed on sponges, bryozoans, ascidians and molluscs. Other starfishes are detritus feeders (detritus = organically enriched film that covers rocks) or scavengers. Some starfish are specialized feeders, for example the crown-of-thorns that feeds on life coral polyps.

Starfish have no hard mouth parts to help them capture prey.

Regeneration

The ability of an organism to grow a body part that has been lost

Autotomy

The spontaneous self amputation of an appendage when the organism is

injured or under attack. The autotomized part is usually regenerated.

Budding

Is asexual reproduction in which an outgrowth on the parent organism breaks off to form a new individual

Fission

Self-division into two parts, each of which then becomes a separate and independent organisms (asexual reproduction)

The stomach is extruded over the prey, thus surrounding the soft parts with the digestive organs. Digestive juices are secreted and the tissue of the prey liquefied. The digested food mass, together with the stomach is then sucked back in. This method can be observed, if you turn around a starfish, that sits on prey or sand - you will see the stomach retreating.

Starfish are well known for their powers of regeneration. A complete new animal can grow from a small fragment such as an arm. In some species (*Linckia multifora* and *Echinaster luzonicus*) one of the arms will virtually pull itself away, regenerates and forms a new animal. Autotomy (self amputation) usually is a protective function, losing the body part to escape a predator rather than being eaten. But here it serves as a form of asexual reproduction. In other species of sea stars (*Allostichaster polyplax* and *Coscinasterias calamaria*) the body is broken into unequal parts (= fission) then the missing limbs regenerate.

Predators of starfishes

The crown-of-thorns (*Acanthaster planci*) is one of the largest and the most venomous starfishes. It can reach 50 cm diameter and has numerous (10 to 20) spiny arms with formidable thorn like toxic spines. Don't touch them! A species of small cardinalfishes (*Siphamia fuscolineata*) and a commercial shrimp (*Perliclimenes soror*) live among those spines. The crown-of-thorns feed on live coral polyps. They "graze" the corals which are left behind white and dead. Their predators are the giant triton shell (*Charonia tritonis*) and some puffer fish. Scientists have also found out that some crown of thorns are deterred from eating the coral polyps by the small crabs living among the coral branches (*Trapezia* sp). These crabs defend their coral host by breaking them off at the pedicellaria. Other small crabs (*Tetralia* sp) only pinch the tube feet of the starfish. Crown of thorns prefer corals, that are not hosts to these crabs.

The cushion star (*Culcita nouvaeguineae*) doesn't look like a starfish at all, more like a large sea urchin without spines. Its pentagonal appearance gives only the slightest indication that this organism is related to other starfish.

Feather stars

(Crinoidea)

Characteristics of feather stars

Feather stars also known as crinoids. They are characterized by radial symmetry. The body of a typical feather star is cup-shaped, their numerous feathery arms project from a central disc. Some have five arms, others as many as 200. The arms, called pinnules are coated with a sticky substance that helps to catch food. There are appendages known as cirri attached to the

underside of the body with which they cling to sponges or corals. Both their mouth and their anus are situated on the upper side.

Ecology and range of feather stars

Feather stars are primarily nocturnal but they are seen in the open during the day with their arms rolled up.

Behavior of feather stars

Feather stars can crawl, roll, walk and even swim but usually they cling to sponges or corals. Feather stars are very abundant in areas exposed to periodic strong currents, because they feed on planktonic food.

Numerous animals live in close association with feather stars. Echinoderms are hosts to various symbiotic animals such as the crinoid clingfish (*Discotrema crinophila*), the elegant squat lobster (*Allogalathea elegans*) or the crinoid shrimp (*Periclimenes* sp.). These animals receive shelter and food (left over) and also feed on microorganisms living on feather stars.

Brittle stars

(Ophiuroidea)

Basket star

(*Astroboa nuda*)

Characteristics of brittle stars

Brittle stars are close relatives of sea stars. Characterized by radial symmetry with a central body from which five snakelike arms protrude. The arms are highly flexible. There is no replication of internal organs, just one set in the central disk. Compared to starfish, brittle stars have a much smaller central disc and no anus. Wastes are eliminated through the mouth which is situated on the underside center.

On the underside of the body disk there is a slitlike opening at the base of each side of each arm. These ten openings are breathing and reproductive outlets, taking in water for oxygen and shedding eggs or sperm into the sea.

The basket stars are a specialized type of brittle stars. They have a series of complexly branched arms which are used to catch plankton.

Serpent stars are seen coiled snakelike around branches of gorgonians.

Ecology and range of brittle stars

Brittle stars are very cryptic and hide in crevices under corals. Best seen at night time, when they emerge to feed on plankton.

Usually at places exposed to strong currents.

Serpent stars feed mostly on small invertebrates like mollusks, worms and crustaceans and are generally found in crevices and beneath rocks or in holes in the sand.

Snake stars (for example *Ophiothela danae*) are found entwined in the branches of black corals or gorgonians where they feed on the rich mucus of their host, in turn performing cleaning functions.

Behavior of brittle stars

As the name suggests, the arms of the brittle stars are rather liable to break. This is actually an escape mechanism. Those arms regenerate quickly and an entire new organism can regenerate, if the broken arm is attached to a seizable portion of the disk. Brittle stars can reproduce asexually by self-division. Brittle stars are the most active and fastest moving echinoderms.

Brittle stars feed on plankton but also on detritus, coral-shed mucus, bottom detritus (detritus = organically enriched film that covers rocks), mollusks and worms.

Sea urchin

(Echinoidea)

Characteristics of sea urchins

Radial symmetrical body with a external chitinous skeleton and a centrally located jaw (called Aristotle's lantern) with horny teeth. The mouth consists of a complex arrangement of muscles and plates surrounding the circular opening. The anus is located on the upper surface. Some sea urchins have a spherical, bulb like cloaca (to store fecal material) that protrudes from the anal opening. It can be withdrawn into the shell.

Depending on the species, movable spines of various sizes and forms are attached to the body. These spines often are sharp, pointed and in some cases even venomous. Pincer like pedicellaria for grabbing small prey. Some pedicellaria are also poisonous.

Ecology and range of sea urchins

Rubble and sand. An abundance of sea urchins can be a sign for bad water conditions.

Behavior of sea urchins

Locomotion by tube feet but also by movement of the spines on the underside of the body. Sea urchins are generally nocturnal,

during the day they hide in crevices. However some sea urchins such as *Diadema* sometimes form large aggregations in open exposed areas. Despite their sharp spines sea urchins are easy game for some fishes, particularly triggerfishes and puffers. A triggerfish grabs the sea urchin with its hard beak like mouth by the spines or it blows some water towards the sea urchin and turns it on its back. The underside of a sea urchin has much shorter spines and those are easily crushed. During the breeding season the body cavity is crammed with eggs or sperms. This is one of the main reasons urchins are so attractive to fish predators (Japanese also like them for the same reason).

Some sea urchins are camouflaged. They hold on with their tube feet onto some bottom debris like rubble or pieces of seagrass and carry them on their back. Some even carry live soft corals or anemones.

Most sea urchins are algal grazers but some feed on sponges, bryozonans and ascidians and others on detritus (detritus = organically enriched film that covers rocks).

The sexes are separate and the young are formed indirectly by the fusion of sperm and eggs released into the water.

Sea urchin cardinalfish

(*Siphamia versicolor*)

Shrimpfish

Aeoliscus strigatus - Centriscidae)

Sea urchin shrimp

(*Stegopontonia commensalis*)

Mandarinfish, dragonet

(*Synchiropus splendidus*)

Many animals live in symbiotic relation with sea urchins. Even on the poisonous spines of the fire urchin (*Asthenosoma varium*) small shrimps (*Periclimenes colemani*) can be found. One shrimp (*Stegopontonia commensalis*) is striped black and white lengthwise and perfectly camouflaged and lives in spines of the long-spined sea urchin (*Diadema setosum*). Some cardinalfishes and juvenile shrimpfishes also like to take shelter in-between these spines, but even small cuttlefish hide there. It has been observed, that they change their coloring also to black and white. Some flatworms wrap around the thicker spines of the diadema sea urchin (*Echinothrix calamaris*).

The mandarin dragonet (Mandarinfish) lives close to congregations of sea urchins and hides among them if threatened.

There are two specialized types of sea urchins with an unusual appearance: the sand dollar is very much flattened with very small spines and the heart urchin which are oval and have bristle like spines. The both bury in sand. The heart urchin "jumps" out of the sand, when disturbed.

Characteristics of sea cucumbers

Unlike other echinoderms, holothurians don't have a distinct radial symmetry but are bilateral (distinct dorsal and ventral

side). Holothurians are also called sea cucumbers. As their name suggests, they are cucumber shaped with an elongated, muscular, flexible body with a mouth at one end and the anus at the other. Around the mouth there is a number of tentacles (modified tube feet) used in food collecting. Sea cucumbers come in many sizes, from small species only a few centimeters in length to long snakelike animals which may stretch up to 2 meter!

Ecology and range of sea cucumbers

Rubble, rocks and sand. Also seen on some sponges in large aggregations.

Behavior of sea cucumbers

Most species feed on the rich organic film coating sandy surfaces. They crawl over the bottom ingesting sand. The edible particles (organic matter such as plankton, foraminifera and bacteria) are extracted when passing through their digestive tract and the processed sand is expelled from the anus (as worm-like excrements).

Sea cucumbers move by means of tube feet which extend in rows from the underside of the body. The tentacles surrounding the mouth are actually tube feet that have been modified for feeding.

Other holothurians feed on current-borne zooplankton. They bury in sand extruding their featherlike tentacles (*Pseudocolochirus violaceus*, *Neothyndium magnum* or *Pentacta crassa*). The tentacles have the same shape as soft corals or some anemones. Large congregations of some small species are found on sponges. They apparently feed on substances secreted by the sponges as well as detritus from the surface.

Some species of holothurians have separate sexes others are hermaphrodites. The sea cucumbers hold on to exposed rocks or corals, raise their body to a upright position, rock back and forth and release the sperm and eggs into the sea.

Sea cucumbers have a remarkable capacity for regenerating their body parts. When attacked they shed a sticky thread like structure which is actually parts of their guts. The so called Cuvierian threads are toxic (the poison is called holothurin) and can dissuade many potential predators. These structures quickly regenerate. (see photos below)

Holothurians host a variety of symbiotic organisms: crabs, shrimps, worms and even a very unusual fish. The pearlfish (*Encheliophis homei* and *mourlani* / *Onuxodon margaritiferae*) has a long slender, transparent body and lives in the gut cavity of

the sea cucumber (*Boshida argus*, *Thelanota ananas*, *Stichopus chloronotus*). They also inhabit some starfish as well as pearl oyster shells. The fish leaves and enters (tail first) through the holothurian's anus. They probably feed on the gonads and other tissues of its host. It is said to leave at night to feed on small fishes and shrimps. Sea cucumbers are used in Asia as a base for soups.

Lesson 8: Marine Mammals

Essential Question:

Why are marine mammals not like the other organisms in the ocean?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.
- LA.4.1.5.1: Demonstrate the ability to read grade level text.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Vocabulary

- Cetaceans
- Mammals
- Toothed
- Baleen
- Blubber

Teacher Background Knowledge:

- Students will learn how mammals maintain a fairly constant body temperature under various conditions.
- Students will understand what blubber is and its function in marine mammals.
<http://www.tmmc.org/learning/education/mammalinfo/mammals.asp>
- <http://www.whaletimes.org/>

Materials:

- Pictures of animals on small cards, vegetable shortening, gloves, alcohol thermometer, bowls, ice, paper towels, water

Procedure:

1. Introduce the vocabulary words by having them on the board and discussing them – **5 min.**
2. The students will be asked to call upon their previous knowledge of mammals in order to assist them in understanding the activity. This will be accomplished through the use of pictures of marine mammals such as walrus, polar bears, dolphins, whales, and seals. Students will also look at pictures of mammals that live in warm climates (tigers, elephants, giraffes) and animals that live in cold climates (wolves, elk, snow hares). These pictures will all be presented to the students on cards. Each student will receive a card and be asked to discuss that animal's characteristics. Example questions include:
 - What is the animal? Where does the animal live?
 - What is the climate like where they live?
 - How does this animal cool off/warm up?When all of the cards have been explained the students will be asked what all of the animals have in common. This will be the characteristics that all mammals share. After viewing the pictures the students will be able to make the connections between mammals and their characteristics and will recall their previous knowledge. The discussion will lead the students into concluding that the characteristics of mammals are that they are warm blooded, give live birth, have hair, breath air and have lungs, exhibit parental care, have mammary glands, and have a placenta – **15 min.**
3. The presenter will ask the children to compare and contrast land mammals such as elephants, dogs, tigers, and kangaroos to marine mammals. The presenter will then propose the question, "how do mammals that live in the ocean keep warm?" This will guide the discussion to the use of blubber in thermoregulation (Appendix A) – **5 min.**
4. Stem Lab: Thermoregulation – **30 min.**
 - Divide the group of students into smaller groups (3-4 in a group).
 - Next, the two groups will each be given a large bowl filled with water, ice, and rubber gloves. The students will be directed to place the ice in the bowl, creating an arctic-ocean environment. The students will wait three minutes for the water to chill. While they are waiting they will be instructed on how to use the student data sheet (Appendix C), which is self-explanatory, and each group will be given a sheet.
 - After the water has chilled, the students will take the temperature of their water and record that data in the appropriate box on the data sheet.
 - The students will then place their hand in the water for 30 seconds and telling the other students how it feels. For example, does his or her hand feel cold? Does it hurt at all? How do you feel? The other students will record these observations on the data sheet. When everyone has finished experiencing the water temperature they will move onto the next phase.
 - Dry off the wet gloves and then liberally apply vegetable shortening to their gloved hands. A second glove will be added to represent the dermal layer, which covers the insulating

- blubber of marine mammals. Once again the students will take turns placing their hands in the water for 30 seconds, making observations and recording observations.
5. Assessment – **5 min.**

Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions
- Discussion – Teacher will ask the following questions:
 - What was the difference between the first time their hand was in the water and the second time? Why did it feel different?

Possible responses: The first time there was no insulation...

- What does this experiment show about the function of blubber?

Possible responses: Blubber acts as an insulator for mammals...

- Besides blubber, what are some other physical characteristics that help keep animals warm in cold climates?

Possible responses: Fur, hair, behavior, metabolism...

Appendix A

Similarities:

Whales/Walrus	Elephant/Tiger
* hair	* hair
* warm blooded	* warm blooded
* fat reserves	* fat reserves
* give birth	* give birth

Differences:

Whales/Walrus	Elephant/Tiger
* sustains swimming and diving for long periods of time	* short bursts of energy
* can't live away from water	* can't live in water
* blubber layer	* fat layer

Appendix B

Student Data Sheet

Students Name	Water Temperature	Observations without Shortening	Observations with Shortening

Information from: <http://www.tmmc.org/learning/education/mammalinfo/mammals.asp>. Retrieved on June 25, 2009.

Introduction to Marine Mammals

Mammals are a special group of animals, with a combination of characteristics that separate them from all others: mammals are warm-blooded, have hair or fur, breathe air through lungs, bear live young, and nurse young with milk produced by mammary glands.

Marine mammals have the same characteristics as all other mammals, but they have adapted or adjusted to life in the ocean. To keep warm in the ocean, most of them depend more upon a thick layer of blubber or fat than on thick fur. They have streamlined bodies to help them swim faster. They can stay under water for a long time, but must come to the surface to breathe. To be able to stay under water for long periods, they store extra oxygen in their muscles and blood. They also have more blood than land mammals in proportion to their body sizes, can direct their blood flow to only their vital organs (such as their heart and lungs), and can slow their heartbeat down so they are using less oxygen in a dive.

All marine mammals are protected in the United States by the Marine Mammal Protection Act of 1972. There are also international laws and treaties that protect marine mammals. Unfortunately, there are still threats to marine mammal populations, such as illegal hunting, pollution, and habitat loss. Learn more about these issues and tell others, including lawmakers, how you feel about them. Together, we can solve or prevent many of the problems our ocean friends face.

There are five distinct groups of marine mammals:

- Pinnipeds – seal, sea lions, fur seals and walruses
- Sea otters
- Cetaceans – whales, dolphins and porpoises
- Sirenians – dugongs and manatees
- Polar bears
- Endangered Marine Mammals

For more information on the classification and characteristics of the five groups of marine mammals, see our [Marine Mammal Classification](#) page.

Lesson 9: Stinging Cells

Essential Question:

What do all stinging-cell animals have in common?

Content Standards:

- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.
- LA.4.1.5.1: Demonstrate the ability to read grade level text.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Vocabulary

- Stinging cells
- Invertebrates
- Jet propulsion
- Tentacle

Teacher Background Knowledge:

- Students will research a marine invertebrate and create an illustrated report
- <http://www.dmturner.org/Teacher/Library/5thText/InvPart2.html>

Materials:

- Computer with Internet access, print resources about ocean life and marine invertebrates, paper, pens, pencils, paint, markers, other art supplies as needed

Procedure:

1. Start the lesson by showing the video *Coral Ecosystems* on www.unitedstreaming.com – **6 min.**
2. Write the following categories on the board: fish, mammals, and invertebrates. Explain that most marine animals fall into one of these three groups. Ask students to name as many characteristics as they can for each category, including how the animals move, reproduce, breathe, and eat, and their physical characteristics. Examples: – **10 min.**

Fish

- a. have skeletons
- b. swim with fins
- c. breathe underwater using gills
- d. are covered with scales
- e. are cold-blooded (temperature changes with surrounding water)
- f. lay eggs

Mammals

- g. breathe air through lungs (must come to surface to breathe)
- h. are warm-blooded (temperature stays the same despite surroundings)
- i. give birth to live young
- j. nurse babies with milk

Invertebrates

- k. have no backbones
- l. may have an exoskeleton (hard protective shell)
- m. may have tentacles

3. After reviewing these characteristics, ask students to name examples of each group featured in the video. Write the animals in the appropriate categories. The video includes the examples below – **5 min.**

Fish: basking shark, blacksmith fish, salmon, herring, rockfish, handfish, leafy sea dragon

Mammals: seal, sea otter, white-sided dolphin, orca

Invertebrates: jellyfish, sea slug, lobster, crab, octopus, shrimp, squid, sea squirt, anemone, sea urchin

4. Tell students that they will focus on marine invertebrates. Remind them that there are many kinds of invertebrates, which have different characteristics. In fact, invertebrates are some of the most unusual and extraordinary creatures in the ocean.
5. Have students work in pairs to research a marine invertebrate. Pairs can choose an animal from the video, or focus on another species they may find in their research. For each invertebrate, students will create an illustrated report that includes the information below.
 - a. Name of animal species
 - b. Size (length or height and weight; give a range)

- c. Physical characteristics
 - d. Where does this animal live?
 - e. How does it move?
 - f. What does it eat?
 - g. How does it eat? (How does it capture its prey or gather its food?)
 - h. How does it breed?
 - i. How does it defend itself?
6. Students may conduct research using print and Internet resources. These Web sites may be helpful:
- a. Ocean Animals (see “Invertebrates”)
 - <http://mbgnet.mobot.org/salt/animals/index.htm>
 - b. Picture Guide to Marine Invertebrates
 - <http://www.oceanoasis.org/fieldguide/findit/invertebrates.html>
 - c. Sea World: Animal Bytes (see “invertebrates”)
 - http://www.seaworld.org/AnimalBytes/animal_bytes.html
 - d. Yahoo!igans: Invertebrates
 - http://www.yahooligans.com/Science_and_Nature/Living_Things/Animals/Invertebrates/
 - e. Secrets of the Ocean Realm: Sea Dwellers
 - <http://www.pbs.org/oceanrealm/seadwellers/index.html>
 - f. Life on the Rocky Shore (Tidepool Animals)
 - <http://www.library.thinkquest.org/J001418/animals.html>
 - g. Invertebrates (Photos only)
 - <http://www.divebums.com/FishID/Invertebrates.html>
 - h. AquaFacts: Maine Invertebrates
 - http://www.vanaqua.org/Visitor_Information/AquaFacts/Marine_Invertebrates.htm
 - i. Species: Who They Are (see Anemones, Blue Crabs, Horseshoe Crabs, Jellyfish, Octopus, Squid, and Cuttlefish). <http://209.251.35.100/animals/species/index.html>
7. When they have gathered enough information, have students write a brief report about their invertebrate and create a colorful illustration, painting, or 3-D model. They must label or highlight important parts of their animal.
8. Have students hang their illustrations around the classroom or on a designated bulletin board. Have them present strange but true or other interesting facts about their invertebrate.

Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions and art work.
- Students’ presentations.

Information from: <http://www.dmtturner.org/Teacher/Library/5thText/InvPart2.html>. Retrieved on June 27, 2009.

Sponges, Stinging Cell Animals, and Flatworms

Porifera: The Sponges

Sponges were probably the earliest type of animal. They are almost not animals at all. Sponge bodies are hollow tubes. Their cells are found in simple layers, as if a few types of single-celled organism had gotten together in a group. The cells of a sponge still act like single-celled organisms, because if a sponge is pulled apart into individual cells, it will re-form.

Sponges live in the water and feed by filtering water through pores, or openings, in the surface. The pores trap small bits of food and the water is sent back out. A newly born sponge larva can move around, but adult sponges stay in one place all their lives. (A larva is the newly hatched young of any animal in which the young are very different in appearance from the adults.) They can be many shapes and sizes, and there are about 5,000 species of sponge.

Sponges, even if they do not have a nervous system, can be beautiful. Their skeleton can be made of soft, rubbery spongin, or it can be made of glass or calcium carbonate. The skeletons of the rubbery type used to be used for bathing, though the sponges we use today are usually made artificially.

Cnidaria: The Stinging-Cell Animals

If you have ever seen a jellyfish in the ocean or washed up on the beach, you have seen a cnidarian, or stinging-cell animal. Stinging cell animals include jellyfish, but they also include such creatures as corals and sea anemones, as well as hydras and the Portuguese Man-of-War. There are about 10,000 species of cnidarians.

Like sponges, stinging-cell animals live in the water and have a hollow sac-like body, but they are more complicated than sponges. They have nerves and muscles, for instance, and they are more organized yet they have no head, no brain, and no special organs for breathing.

There are two facts that stand out about stinging cell animals. First, they all have stinging cells which contain a long barbed thread, sometimes poisoned. These threads are used to sting prey and bring it to the jellyfish. Second, stinging-cell animals have an unusual life cycle which alternates between the medusa (floating) and polyp (fixed) stage. An example of a medusa is the familiar jellyfish. When a jellyfish produces eggs, the eggs hatch into polyps which attach themselves to the sea floor. These polyps spend their lives on the sea floor, making more medusas. The mother of a polyp is a medusa, and the mother of a medusa is a polyp.

The deadly Portuguese man-of-war is a stinging-cell animal, but it is not a jellyfish. It belongs to the same group as the hydra, and is a colony of small organisms like the hydra. A colony is a group of the same kind of organisms living and growing together.

Platyhelminthes: the Flatworms

Flatworms, like stinging-cell animals and sponges, have a hollow sac-like body with one opening. The body of a flatworm tends to be long and flattened, however. There are three types of flatworms, two of which are mostly parasites and one which is free-living.

The free-living type includes the planarian. The planarian is a freshwater flatworm which feeds on other small organisms. It has an arrow-shaped head and two small light-sensitive eye-patches which make it look cross-eyed. It is not uncommon to see tiny planaria in ponds and streams, and they are fun to look at under microscopes. If a planarian is cut in half, each half will grow a new planarian.

The other two types are much less pleasant. They are the flukes and the tapeworms. Both types of flatworm are parasites: they live in and feed on other animals.

The tapeworm is a peculiar animal, not only in the way it is built but in its life cycle. It has a small head with hooks which allow it to attach itself to its host, and a long string of segments for a body. It has no real digestive system. It does not need one, because it lives in the host's intestine and eats the host's digested food.

Each segment in a tapeworm's body is a bag of tapeworm eggs. One by one, each segment drops off the end of the worm and passes out of the host. If the eggs are eaten by pigs or cattle, the eggs move into the muscles and hatch. If someone eats the meat of infected pigs or cattle without cooking it properly, the larvae move into the digestive system and start the life cycle over again.

Lesson 10: The Ocean's in Trouble

Essential Question:

What can we do to save our oceans?

Content Standards:

- LA.4.1.5.1: Demonstrate the ability to read grade level text.
- LA.3.2.2.2: Use information from the text to answer questions related to explicitly stated main ideas or relevant details.
- LA.3.1.6.2: Listen to, read, and discuss familiar and conceptually challenging text.
- LA.3.1.6.1: Use new vocabulary that is introduced and taught directly.

Youth Development Standards:

External Assets:

- 3
- 5
- 10
- 12
- 14
- 16
- 18

Internal Assets:

- 21
- 22
- 34
- 35
- 36
- 37

Vocabulary

- Population and Ecosystems

Teacher Background Knowledge:

- The student will identify why oceans are "in trouble."
- <http://www.whoi.edu/science/B/people/kamaral/plasticsarticle.html>
- <http://www.whoi.edu/science/B/people/kamaral/plasticsarticle.html>

Materials:

- Internet access, student's journal, poster board, markers/crayons

Procedures:

1. Start the lesson by asking the students: Why are the oceans in trouble?
2. Watch the video *Marine Harvests and the Endangerment and Extinction of Ocean Species* on <http://www.unitedstreamikng.com> – **7 min.**
3. Students will conduct a mini research of WHY the oceans are in trouble – **25 min.**
 - Divide the class in groups of 3 or 4
 - Students will brainstorm reasons why the ocean is in trouble. Fill in an inspiration cluster map template (Appendix A).
 - Students will then use the Internet to visit the Website and fill in the worksheet (Appendix B).
 - Students will have a discussion with another group of students. They will use Inspiration cluster map and the worksheet to share information.
4. The groups will then choose an important idea or tip to increase the public's awareness about ocean pollution. Make a poster that will be hung in the school or community – **15 min.**
5. Assessment – **10 min.**

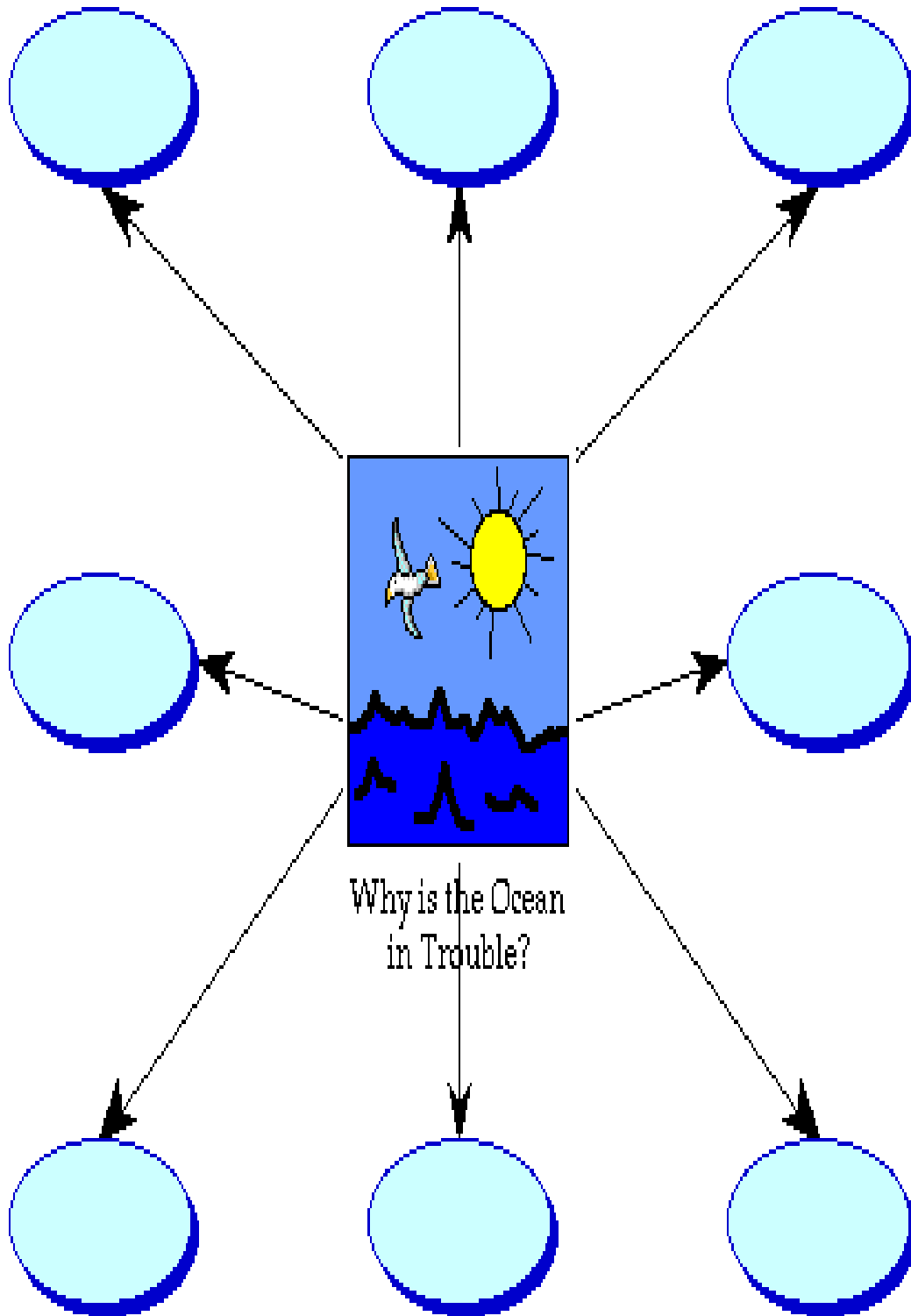
Formative Assessment:

- Observation – Teacher should observe listening, writing, reading, discussions, timeline and art work.
- Students will share their poster with the class.
- Post-assessment: Pass out the K-W-L chart that the students completed the first two columns at the beginning of the unit. They will now complete the last column: What I Learned.

Appendix A

CLUSTER MAP TEMPLATE

Use this cluster map to brainstorm ideas about why the beach could be closed



Appendix B

The Ocean's in Trouble

Directions: Visit each internet site. Please read the information, as well as look at the pictures. Find at least 4 interesting facts or pieces of information from each site. Write your notes on this worksheet. These notes should help you figure out why the ocean “is in trouble.”

- http://see-the-sea.org/topics/pollution/debris/dangerous_debris.htm
- <http://www.whoi.edu/science/B/people/kamaral/plasticsarticle.html>

Dangerous Debris

- 1.
- 2.
- 3.
- 4.

Plastic in our Oceans

- 1.
- 2.
- 3.
- 4.

Information from: http://see-the-sea.org/topics/pollution/debris/dangerous_debris.htm. Retrieved on June 27, 2009.

DANGEROUS DEBRIS

and what YOU can do about it

Marine garbage is the most visible and easily recognized of all ocean pollution and causes serious damage to marine wildlife. Every year millions of marine animals die worldwide because of this type of pollution ([Venizelos, Lily 1998](#)). The small personal pieces of garbage, casually discarded, are often the most damaging. While some of this trash is left directly on the beach, much of it originates as street litter from coastal and inland cities where it is washed down to the sea through storm water drains and rivers. Some trash, particularly plastics, can last in the ocean for years. There are many different items which make up marine garbage, ranging from large commercial fishing nets which can entangle and maim or kill animals, to small plastic bags that can be mistaken for food and ingested by marine life.

Plastics are of most concern because they are not generally biodegradable. However, over time, the sun's ultraviolet rays break down plastic into smaller pieces where they can end up as small as plankton. This breaking down process is very slow, allowing the garbage to continue to float around year after year.

Some debris, like discarded commercial fishing nets, can continue to kill for decades as the trapped animals attract predators, which can then become entangled themselves. Some of the debris reaches the ocean bottom where it can suffocate immobile plants and animals, producing areas essentially devoid of life. The garbage being moved along by the global current conveyor system poses other more insidious problems than entanglement and digestive problems. It has recently been discovered that organisms harmful to delicate ecosystems are hitching rides across the globe on plastic trash, ([Rachel Elbaum, 2002](#)). According to this report, tiny species like barnacles, worms and mollusks are using human garbage as a transport system, thus dealing a blow to biological diversity in fragile ecosystems such as Antarctica and the Galapagos Islands. Plastic is also a transport medium for toxic pollutants. A group of Japanese scientists from [Tokyo University of Agriculture Technology](#) released a study indicating that pre-production plastics (the way that plastics are shipped to end-use manufacturers) are accumulators of hydrophobic pollutants (molecules or molecular groups that mix poorly with water) like DDE and PCB. Based on this latest research, these pollutants can be up to one million times more concentrated on the surface of these pellets than they are in the ambient seawater. ([Yukie et al, 2001](#))

Commercial material transport is also responsible for great volumes of trash being accidentally dumped into the ocean. During foul weather, tankers can lose many large containers that are filled with goods that are being shipped. In 1999, a freighter spill dumped 50,000 pairs of Nike shoes into the Pacific. In 1992, 29,000 bathtub toys packed in 20 giant containers fell off a ship into the Pacific. Dr. Curt Ebbesmeyer of the Beachcombers Organization [www.beachcombers.org] estimates approximately 10,000 containers fall overboard every year, mostly due to storms. Each 8-foot-by-40-foot container can carry up to 58,000 pounds of cargo. ([Ebbesmeyer, Curtis C., 1998-2005](#))

Marine debris has direct negative consequences for humans. Sometimes marine garbage can cause health risks for people because it can carry toxic chemicals or infectious diseases. The near-shore and beached debris is also frequently a cause of cuts and scrapes as well as human entanglement.

There are also many examples of great losses to our economy. In 1988, the potential health hazards of medically related debris as well as high bacterial counts caused extensive beach closures along the northeastern coast of the United States. Estimates of the losses to the Long Island economy alone are as high as \$1 to 2 billion for that one summer (U.S.EPA, 2004). What many people do not realize is that this widely publicized summer of 1988 was not a result of one near-shore illegal dumping. According to the United States EPA, it was determined to simply be a result of all of the accumulated debris from the streets being washed down into the storm sewers which then flowed through other sewer systems. All of it was then flushed into the sea following heavy rains. That summer also had persistent south-southwest winds that collected the floating debris and pushed it to the shore areas.

Marine debris, large and small, also acts as a navigational hazard to fishing and recreational boats. Larger debris, such as shipping containers, present a dangerous collision hazard. Smaller items frequently causes expensive and time consuming damage by entangling propellers and clogging cooling water intake valves.

What can you do about it?



Reduce, Reuse and Recycle.

- Choose to buy items with less packaging, which generates less trash.
- Use reusable shopping bags.



Contact manufacturers to let them know that you want to see less packaging used with their products.



Dispose of the trash you do have correctly. Even if you live far from the ocean, trash can go to the ocean via rivers, causing damage and unsightliness along the way.

- Recycle whenever possible.
- Discard trash in closed containers.
- Keep cutting up those six pack ring-holders. Even if you don't live near the ocean, this lowers the risk of entanglement to marine animals if the ring-holders do make it out to sea.
- Take the time to retrieve broken fishing line because these are hazardous for wildlife.
- Do not throw cigarette butts in the water or on beaches or in other areas where these may

- end up in the water. Marine birds or fish may eat them and become ill or die.
- Pick up any litter that you may find in the water or along the shoreline and then dispose of it properly.
 - Participate in coastal and beach clean-up programs.



Avoid flushing items which are not easily biodegradable down the toilet.

- If you live near or visit an area which is affected, contact you local government to let them know of the problem and how it negatively affects your area. This will encourage possible legislative changes.



Your Voice counts. Make sure your opinions and concerns are heard by government and industry leaders by using the contact information provided on our [Your Voice Counts](#) page.

Information from: <http://www.who.edu/science/B/people/kamaral/plasticsarticle.html>. Retrieved on June 27, 2009.

Plastics in Our Oceans

by Kimberly Amaral

Strolling through the average supermarket, shoppers find literally hundreds (if not thousands) of items to make their lives easier. Individually wrapped snack cakes, plastic baggies to store sandwiches for lunch, unbreakable soda bottles, and disposable razors, diapers, and shampoo bottles. Unless specifically requested, even the bags we use to carry home our goods are often plastic.

To humans, these are items of comfort, if not necessity. But to marine animals, they can be a floating minefield.

But when plastic reaches our waters, whether it be plastic bags or drifting fish nets, it poses a threat to the animals that depend on the oceans for food. To a sea turtle, a floating plastic bag looks like a jellyfish. And plastic pellets--the small hard pieces of plastic from which plastic products are made--look like fish eggs to seabirds. Drifting nets entangle birds, fish and mammals, making it difficult, if not impossible to move or eat. As our consumption of plastic mounts, so too does the danger to marine life.

Before the days of plastic, when fishermen dumped their trash overboard or lost a net, it consisted of natural materials--metal, cloth or paper that would either sink to the bottom or biodegrade quickly. But plastic remains floating on the surface, the same place where many genuine food sources lie--and can remain so for 400 years. Plastic is durable and strong--precisely the qualities that make it so dangerous if it reaches the ocean.

It *can* get there from here

But how would a syringe that a diabetic uses make it into the ocean? If plastic objects make it into the main sewer system (say, by being flushed down the toilet, or carried by the rain into a street drain), and the water treatment plants are overwhelmed by excessive rain, then those floating objects can float right out to sea. This is precisely what happened on the New York and New Jersey beaches in 1988, when medical waste was floating up onshore. After an unusually dry spring, litter began accumulating on the streets and in storm sewers. When heavy rains arrived in mid-summer, they swept the streets clean and overloaded combined sewers. After floating out to sea, the debris was blown back onto the shores.

In a more direct route, boaters may dump their trash right into the sea. In the past, this has been the main cause of plastics in the ocean. In 1975, the National Academy of Sciences estimated that 14 billion pounds of garbage was being dumped into the ocean every year. That's more than 1.5 million pounds per hour. More than 85% of this trash was estimated to come from the world's merchant shipping fleet

in the form of cargo-associated wastes. According to the Academy, the United States could be the source of approximately one third of this ocean pollution.

Fortunately, since the last day of 1988, it has been illegal for ships to dump plastics into the ocean. But that law is difficult to enforce, and cannot account for the thousands of miles of driftnets and other gear set by fishermen, which can ensnare and kill birds diving for the fish below, or come loose, only to be discovered later by an unfortunate humpback whale.

It's a great big world out there

Anyone who's been on a boat far from the sight of land will tell you how enormous the ocean feels. Wouldn't this debris simply get dispersed, virtually eliminating the possibility of an encounter with a marine animal? The answer is no. While the ocean does disperse the trash, it also runs in currents, which can keep the floating trash traveling constantly in "gyres," concentrating it in areas where currents meet. The largest of these movements, is called the central gyre. It moves in a clockwise circular pattern, moving inside the Gulf Stream, and dominates the western North Atlantic. Studies begun in 1984 have tracked how these currents keep plastics migrating, with heavy concentrations in the northern Sargasso Sea (coincidentally, a favorite spawning place for fish). The Northeast United States, "upstream" of the central gyre, has currents that keep most of the locally generated marine debris local. Usually the only ways to escape this constant circular pattern is if the plastic decays enough to sink, or lands onshore to be (hopefully) picked up by a passer-by.

And apparently, the ocean isn't large enough to avoid marine life encounters with debris. Plastic's devastating effect on marine mammals was first observed in the late 1970s, when scientists from the National Marine Mammal Laboratory concluded that plastic entanglement was killing up to 40,000 seals a year. Annually, this amounted to a four to six percent drop in seal population beginning in 1976. In 30 years, a 50% decline in Northern Fur Seals has been reported.

Elephant seal entangled in fishing line. Photo by John Domont. Courtesy of the Center for Marine Conservation.

These curious, playful seals would often play with fragments of plastic netting or packing straps, catching their necks in the webbing. The plastic harness can constrict the seal's movements, killing the seal through starvation, exhaustion, or infection from deep wounds caused by the tightening material. While diving for food, both seals and whales can get caught in translucent nets and drown. In the fall of 1982, a humpback whale tangled in 50 to 100 feet of net washed up on a Cape Cod beach. It was starving and its ribs were showing. It died within a couple of hours.

Along Florida's coasts, brown pelicans diving for fish sometimes dive for the bait on a fisherman's line. Cutting the bird loose only makes the problem worse, as the pelican gets its wings and feet tangled in the line, or gets snagged onto a tree.

Plastic soda rings, "baggies," Styrofoam particles and plastic pellets are often mistaken by sea turtles as authentic food. Clogging their intestines, and missing out on vital nutrients, the turtles starve to death. Seabirds undergo a similar ordeal, mistaking the pellets for fish eggs, small crab and other prey, sometimes even feeding the pellets to their young. Despite the fact that only 0.05% of plastic pieces

from surface waters are pellets, they comprise about 70% of the plastic eaten by seabirds. These small plastic particles have been found in the stomachs of 63 of the world's approximately 250 species of seabirds.

Wildlife is not the only area to suffer from the effects of marine debris. Plastic bags are the leading external cause of marine engine damage in Massachusetts. Other plastic items foul propellers and interfere with fishing tackle.

What's being done about plastics

In 1987, a law was finally passed restricting the dumping of plastics into the ocean. The Marine Plastic Pollution Research and Control Act (MARPOL) went into effect on December 31, 1988, making it illegal for any U.S. vessel or land-based operation to dispose of plastics at sea. It is part of an international treaty, where countries representing at least half of the shipping fleet tonnage in the world agreed to Annex V of the treaty, preventing "pollution by garbage from ships." It prohibits the dumping of plastics anywhere in the ocean, and the dumping of other materials, such as paper, glass, metal, and crockery, closer to shore.

The plastics industry has also stepped in, taking measures to reclaim plastic resin pellets that often get lost during production or transport. The Society of the Plastic Industry has produced many public service ads for trade magazines, and was a strong supporter of MARPOL Annex V.

Plastics manufacturers are also investigating ways to create "degradable" plastics. Although all materials eventually break down, a plastic soda ring can take up to 400 years to biodegrade. So researchers are working with two types of degradable plastics: photodegradable and biodegradable.

Photodegradable plastics are made to become weak and brittle when exposed to sunlight for prolonged periods. At least 16 states--Massachusetts, New York and Rhode Island included--have passed laws requiring six-pack holders be biodegradable (these are marked by a small diamond between the rings).

Biodegradable plastics are made with cornstarch, so bacteria and other organisms eat away at the plastic, breaking it up into smaller pieces. Neither of these methods, however, solves the problem of plastic in the oceans, since they are only broken up into smaller pieces--creating an even more dangerous situation for animals that mistake smaller plastic pieces for food.

Perhaps the most effective method right now for solving the persistent plastic problem is beach cleaning. Coastal cleanups gather volunteers to collect trash that has washed up on the beach--or has been left by beachgoers to be carried out by the surf--and removed it from the marine cycle.

The Center for Marine Conservation has been coordinating coastal cleanups since 1986. (The first nationwide cleanup took place in 1988, just four months before the MARPOL treaty took effect. Canada and Mexico joined in on the act in 1989.) The CMC also keeps careful track of all the debris that is collected. Data cards list 85 debris items in eight categories: plastic, styrofoam, glass, rubber, metal, paper, wood and cloth. During the 1993 coastal cleanup, over 3.1 million pounds of trash was collected--more than half of that was plastic.

The CMC also divides their data into debris found, listing the "dirty dozen"--twelve items found most frequently:

- cigarette butts
- paper pieces
- plastic pieces
- Styrofoam
- glass pieces
- plastic food bags
- plastic caps and lids
- metal beverage cans
- plastic straws
- glass beverage bottles
- plastic beverage bottles
- Styrofoam cups

Debris that can be traced to recreational fishing and boating, galley-type wastes, and cruise ship debris all declined in 1993—perhaps a glimmer of hope resulting from the MARPOL treaty. The laws, enforced by the Coast Guard in the United States, are difficult to monitor. Instead, they rely heavily on an educational campaign, bringing about "voluntary compliance through awareness."

There is still much debris floating around our seas and endangering marine animals. But as more laws are passed, and as more people become involved in projects like beach clean-ups, perhaps the only plastic will be in our supermarkets.

What you can do

- Look for alternative materials or avoid excessive packaging when deciding on purchases. Use paper bags, milk and juice in cardboard, and cloth diapers. Insist on paper bags and glass bottles.
- Recycle. Many communities currently offer pick-up recycling programs for #1 and #2 plastics. Other forms of plastic may be accepted by a local recycling business. If your community doesn't have a recycling program, contact your city or town hall to request one.
- Educate others about the problem of marine debris, enhancing "voluntary compliance through awareness."
- Get involved. [Locate or start a coastal cleanup in your area.](#)