From Sails to Submarines:
Human Exploration and the Ocean

INTRODUCTION

Through this lesson, students will examine the history of ocean exploration throughout human civilization. They will learn about early human exploration and how civilization expanded their presence by island hopping across the Pacific Ocean. Students will also study Ferdinand Magellan and Captain James Cook's exploration endeavors to provide examples of voyages during the Age of Exploration. Students will trace the evolution of navigational tools from when explorers first set out on the waters to travels deep into the ocean to realize how these tools became more sophisticated enabling further travel. Students will then continue to discover more about modern ocean exploration by traveling far below sea level. Through detailed descriptions and pictures, students will uncover a variety of different organisms from the depths of our oceans and learn about the conditions these creatures live in.

LESSON OVERVIEW

Grade Level & Subject: Grades 3-6: Social Studies

Length: 1 – 2 sixty minute class periods

Objectives:
After completing this lesson, students will be able to:

- Describe how ocean exploration has changed throughout human civilization
- Identify the path that early East Asian islanders used to travel through the Pacific Ocean
- Understand changes in navigational capabilities that helped foster and define the Age of Exploration
- Introduce deep sea dwellers and the characteristics these organisms share in their unique environment

National Standards Addressed:[1]
This lesson addresses the following National Social Studies and History Standards from the National Council for the Social Studies:

- **Content Standard: NSS-G.K-12.1 THE WORLD IN SPATIAL TERMS**
  As a result of activities in grades K-12, all students should

[1] http://www.education-world.com/standards.

        - Understand how to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.
        - Understand how to analyze the spatial organization of people, places, and environments on Earth's surface.
- **Content Standard: NSS-G.K-12.2 PLACES AND REGIONS**
  As a result of activities in grades K-12, all students should
    - Understand the physical and human characteristics of places
- **Content Standard: NSS-G.K-12.4 HUMAN SYSTEMS**
  As a result of their activities in grades K-12, all students should
    - Understand the characteristics, distribution, and migration of human populations on Earth's surface.
    - Understand the processes, patterns, and functions of human settlement.
- **Content Standard: NSS-G.K-12.5 ENVIRONMENT AND SOCIETY**
  As a result of activities in grades K-12, all students should
    - Understand how human actions modify the physical environment.
    - Understand the changes that occur in the meaning, use, distribution, and importance of resources.
- **Content Standard: NSS-G.K-12.6 THE USES OF GEOGRAPHY**
  As a result of activities in grades K-12, all students should
    - Understand how to apply geography to interpret the past.

This lesson addresses the following National Standards for History from the National Center for History in the Schools.

- **Content Standard: NSS-G.K-12.6 THE USES OF GEOGRAPHY**
  As a result of activities in grades K-4, all students should
    - Understand selected attributes and historical developments of societies in Africa, the Americas, Asia and Europe.
    - Understand major discoveries in science and technology, some of their social and economic effects, and the major scientists and inventors responsible for them.

Materials Needed:

- Paperclips
- Cork
- Magnets
- Colored Markers
- Cups
- Hiking Compasses
- Colored Pencils
- Rulers
- Pencils/Pens
- **Reproducible #1 – Exploration Pictures** (plus cardboard mounts to give more structure to the pictures if preferred)
- **Reproducible #2 – Oceania Locations/Stations Descriptions**

- **Reproducible #3 – Voyage Vocabulary**
- **Reproducible #4 – Island Hopping Across the Pacific**
- **Reproducible #5 – Actual Path of Pacific Islanders**
- **Reproducible #6 – Making a Compass**
- **Reproducible #7 – Aliens in the Deep** (plus cardboard mounts to give more structure to the pictures if preferred)
- **Reproducible #8 – Create–a–Creature**

Assessment:
Students will be assessed through the following activities:

- Participation in class discussions and verbal activities
- Successful completion of Island Hopping Across the Pacific Activity
- Completion of Create – a – Creature and Island Hopping Across the Pacific Worksheet
- Construction of a basic compass

LESSON BACKGROUND

Relevant Vocabulary:

- **Archipelago**: A large group or chain of islands.[2]
- **Bioluminescence:** The emission of light from living organisms as a result of the oxidation of a light-producing substance; it occurs in many marine organisms and insects, such as the firefly.[3]
- **Climate**: The common weather conditions of a region; the temperature, the amount of air pressure, humidity, rain, sunshine, cloudiness and wind over a period of time. [4]
- **Compass:** A device for determining directions by means of a magnetic needle or group of needles turning freely on a pivot and pointing to the magnetic north.[5]
- **Ecosystem**: The plants and animals that are found in a particular location. These plants and animals depend on each other to survive. [6]
- **Equator**: The equator is an imaginary line between the northern and Southern hemispheres. Most places along the equator have a common temperatures and abundant exposure to the Sun.[7]
- **Expedition:** A journey or excursion undertaken for a specific purpose.[8]

---

[2] "Climate." Dictionary.com, LLC. Retrieved March 4 2011 from http://dictionary.reference.com/browse/climate.
[3] "Bioluminescence Entry" Merriam-Webster Online Dictionary. Retrieved February 28 2011 from http://www.merriam-webster.com/dictionary/bioluminescence.
[4] "Archipelago Entry." Dictionary.com, LLC. Retrieved March 4 2011 from http://dictionary.reference.com/browse/archipelago.
[5] "Compass Entry." Merriam-Webster Online Dictionary. Retrieved February 28 2011 from http://www.merriam-webster.com/dictionary/compass.
[6] "Ecosystem Entry." *National Geographic Xpeditions*. Retrieved March 4 2011 from http://www.nationalgeographic.com/xpeditions/lessons/08/gk2/ecosystem.html.
[7] "Equator." Scholastic. Retrieved March 4 2011 from http://www2.scholastic.com/browse/article.jsp?id=3595.
[8] "Expedition Entry." Merriam-Webster Online Dictionary. Retrieved February 28 2011 from http://www.merriam-webster.com/dictionary/expedition.

- **Rainforest**: A tropical forest with many, tall evergreen trees (trees that keep their leaves all year) in an area where is extremely plentiful.[9]
- **Sextant:** An instrument for measuring angular distances used especially in navigation to observe altitudes of celestial bodies (as in ascertaining latitude and longitude).[10]
- **Submarine:** A vessel that can be submerged and navigated underwater.[11]
- **Volcano**: A volcano is a mountain that opens downwards to a pool of molten rock below the surface. When pressure builds up, eruptions occur. Gases and rock shoot up through the opening and spill over or fill the air with lava fragments. An active volcano is a volcano that has erupted recently and will erupt again. A dormant volcano is a volcano that is not currently active but may be again one day. [12]
- **Wetland**: Land that has a wet and spongy soil, as a marsh, swamp or bog. [13]

Information:
Human exploration of the ocean has a long and impressive pedigree. The first humans to travel across waters used very simple boats made from materials such as stalks from tall grasses (known as reed), lightweight wood from balsa trees and single hollowed tree trunks. Initially, ocean travel was only used to traverse short expanses. Yet, at some point, substantial distances were traversed. For example, people from Southeast Asia journeyed across the Pacific Ocean by gradual "island hopping." Some historians even theorize that this is how people eventually reached the Americas. Many will agree, however, that the expansion of human civilization across the Pacific islands was a gradual process taking thousands of years. It was also one of the greatest migrations in human history, considering it took thousands of years for people to even reach remote island areas such as New Zealand.[14]

Another great epoch of oceanic migration was The Age of Exploration, a period of rapid exploration and expansion that lasted from the 15th to 17th centuries and mainly involved European conquests. Development of technologies like the compass, telescope and sextant during this time period allowed explorers to navigate the ocean quicker and with more certainty. By the middle of the 16th century, explorers had the specific knowledge to voyage around the world.[15]

Of course, exploration of the ocean did not stop after the whole ocean surface had been charted. Many modern ocean explorers, for example, now focus their efforts on exploring the ocean's depths. The work of individuals like Jacques Cousteau and Robert Ballard pushed the boundaries of

---

[9] "Rainforest Entry." Dictioary.com, LLC. Retrieved March 4 2011 from http://dictionary.reference.com/browse/rainforest.
[10] "Sextant Entry." Merriam-Webster Online Dictionary. Retrieved February 28 2011 from http://www.merriam-webster.com/dictionary/sextant.
[11] "Submarine Entry" Merriam-Webster Online Dictionary. Retrieved February 28 2011 from http://www.merriam-webster.com/dictionary/submarine.
[12] "Volcano Entry." *Federal Emergency Management Agency*. Retrieved March 4 2011 from http://www.fema.gov/kids/volcano.htm.
[13] "Wetland Entry." Dictionary.com, LLC. Retrieved March 4 2011 from http://dictionary.reference.com/browse/wetland.
[14] "Oceania, 8000–2000 B.C." In *Heilbrunn Timeline of Art History*. New York: The Metropolitan Museum of Art, 2000. Web. 01 Mar. 2011. http://www.metmuseum.org/toah/ht/?period=02&region=oc.
[15] Halsall, Paul. "Modern History Sourcebook: Magellan's Voyage Round the World, 1519-1522 CE." June 1998. Web. 01 Mar. 2011. http://www.fordham.edu/halsall/mod/1519magellan.html.

exploration. For instance, Jacques Cousteau designed the Aqua-lung, the predecessor to the modern SCUBA (self-contained underwater breathing apparatus), and Robert Ballard was able to uncover many famous ship wreckages using remotely operated underwater vehicles (ROVs).[16] Another notable example is Jacques Piccard and his journey to farthest depths of the ocean (more than 35,000 feet) with naval officer Don Walsh in a submersible he designed himself called a bathyscaphe.[17] Underwater exploration continues to reveal many exotic – and oftentimes incredible - findings with many arguing that it is the last unexplored area of the planet.

Resources:

- A webpage that provides fantastic pictures of bioluminescent creatures. A great visual aid for students.
  http://www.wired.com/wiredscience/2011/01/bioluminescent-sea-creatures
- A detailed table that outlines the important events in the timeline of human exploration of the ocean.
  http://www.guilford.edu/original/academic/geology/histofexp.html
- An interactive website created by the Metropolitan Museum of Art that analyzes early human exploration of Oceania through the art found in the region.
  http://www.metmuseum.org/toah/ht/?period=02&region=oc
- Webpage that includes quick facts on the European Age of Exploration.
  http://www.uwgb.edu/dutchs/WestTech/explor.htm
- A National Oceanographic and Atmospheric Administration (NOAA) learning tool that describes how to build a simple compass.
  http://oceanservice.noaa.gov/education/for_fun/MakeyourownCompass.pdf
- This webpage is an extensive biography of Ferdinand Magellan that describes his life and significant voyages.
  http://www.fordham.edu/halsall/mod/1519magellan.html

Websites for Kids:

- Sea and Sky is a great, kid-friendly website describing different deep sea creatures. Each creature has a length description describing what it looks like, what it eats, and how it behaves. There are also quick facts about where each creature lives, its alternate names, and at what depth it may be found. The whole domain, SeaSky.org, is a great website for learning about ocean exploration.
  http://www.seasky.org/deep-sea/deep-sea-intro.html

[16] "Five Questions for Robert Ballard." *Ocean Portal by The Smithsonian Institution | Find Your Blue*. Smithsonian Institution. Web. 01 Mar. 2011. http://ocean.si.edu/ocean-news/passion-exploration/five-questions-robert-ballard.
[17] "A Brief History." *College of Earth, Ocean, and Environment | The College of Earth, Ocean, and Environment*. Web. 01 Mar. 2011. http://www.ceoe.udel.edu/deepsea/level-2/tools/history.html.

LESSON STEPS

Preparation Step:

1. Print out **Reproducible #1 – Exploration Pictures** and cut the pages into individual pictures. If you would like, mount the pictures on cardboard to give them more structure.

2. Before the start of "Activity One," separate the classroom into nine stations, or if the entire school is being utilized, establish stations around the school. Print out **Reproducible #2 - Oceania Locations/Stations Descriptions** and post the description and pictures of each Oceania location at their respective station. Also print out enough copies of **Reproducible #3 – Voyage Vocabulary** and **Reproducible #4 – Island Hopping Across the Pacific** so each student has one of each, and set out colored pencils or crayons for the students to color the maps. Print out a copy of **Reproducible #5 – Actual Path of Pacific Islanders** for yourself.

3. For "Activity Two," cut the corks up into multiple slices – large enough that they remain stable when floating – but small enough so that the paperclips can be pushed through them. Additionally, print out a copy of **Reproducible #6 – Making a Compass** for each student.

4. Before "Activity Three," print out one copy of **Reproducible #7 – Aliens in the Deep** and cut out the pictures. Mount them on cardboard if you would like. Print a copy of **Reproducible #8 – Create–a–Creature** for each student. Also set out colored pencils/crayons for the students to draw their own creatures.

Warm-up: *Past and Present Ocean Exploration*

These questions will encourage students to begin thinking about ocean exploration.

1. Why did people explore the oceans in the past? *To search for new lands, find more resources (food, arable space, fresh water sources, or habitable area), curiosity/adventure, open new trade routes and learn the geography of the world.* Why do people explore the oceans today? *To learn more about the ocean and the Earth, to find new species, to perform medical or science research, etc.*

2. How have navigational methods changed? *At first, people used the sun and stars to determine their direction of travel. After the compass, sextant, and telescope were invented, navigation was fundamentally changed. People also used maps after large portions of the ocean had been charted. Modern sailors use Global Positioning Software (GPS) via satellites to travel on the surface and sonar waves to explore the ocean.*

3. How has ocean-based transportation changed? *Initially, people used small, handmade boats. The sizes of boats have changed over time and technology used to power them has also changed too. From human powered (oars) to wind powered (sails), to steam powered and fossil fuel generation now, ocean-based transportation has substantially changed. Also, People used to travel primarily on the surface; now we have SCUBA and submarines which are used by navies and research scientists to explore the depths of the ocean.* If students do not know what a submarine is, say that it is an aquatic vehicle, like a boat, that can dive under the water and travel that way. Show a picture of the submarine from **Reproducible #1**.

Activity One: *Across the Pacific*

1. Spread out a map of the world. Ask a volunteer to go up to the map and find the Atlantic Ocean. Then, ask another volunteer to find the Pacific Ocean. After both have been pointed out correctly, ask the class as a whole what are some differences between the two oceans. *The Atlantic Ocean is not as wide. The Atlantic is between Europe/Africa and the Americas. The Pacific Ocean is between the Americas and Asia. The Atlantic Ocean is fairly devoid of islands. The Pacific Ocean is full of islands.*

2. Ask students to brainstorm what the earliest boats were like. *Human-powered, canoes made with simple materials like reed and balsa, or dugout boats made from single large logs.* Then, ask them to imagine that they are early humans using simple boats for transportation. If they had a choice between trying to cross the Atlantic or the Pacific Ocean, which would they rather cross? *Many historians think that early humans were unable to travel across the Atlantic Ocean because it is so wide, and there are few islands between the continents. On the other hand, the Pacific Ocean is full of islands so people were able to make shorter journeys from one island to another. In fact, some people theorize that the first people to reach America did so by "island hopping" across the Pacific.*

3. Ask students to imagine that they are early humans in the year 40,000 B.C.E. who live near present day Hong Kong in China, near the Pacific coast. Tell them that they will be embarking on an expedition. Since resources are low, they must make a voyage to discover new livable land and find more food and drinkable water. Explain to the students that they will be reenacting the migration path that many early humans utilized.

4. Give each student a copy of **Reproducible #3 – Voyage Vocabulary** and **Reproducible #4 – Island Hopping Across the Pacific.** Review the vocabulary words from Reproducible # 1.

5. Review **Reproducible # 4** with the class and make sure students understand the goals of the activity. Point to the different stations around the classroom and tell the students that each station represents a different location in the Pacific Ocean. Tell them that at each location, they will find a description of the location's climate, land types, animals and plants. There are also pictures at each location that will help the students to see what the region looks like and what species live there. Students must determine the path they will take across the Pacific by going from station to station. At each station they will read the description, look at the pictures, and read the clue to select the next location. Remind students to look for their vocabulary words at each station (see **Reproducible #3**).

6. Explain to students that they will need to imagine what it would be like to live during early human history. They should use the map from **Reproducible #4** to track their progress. Each station will have clues to help direct students to the next location.

7. Divide students into groups of four to work together to visit each station. As students move around the room, they should chart their route by writing down the name of each location in the order in which they travel to them.

8. Since there is a direct path students should be following, to avoid congestion, it might help

to stagger their starting times. While students are waiting for others to advance, they may color in their maps. If they finish early, they may begin answering the questions at the bottom of **Reproducible #4.**

9. After all the students are done with their expedition and have completed their worksheets, display **Reproducible #5 – Actual Path of Pacific Islanders** and ask students to compare their route with the route that was likely used based on by early humans. Review the answers to the questions with the students. The answers are at the bottom of **Reproducible #5**.

Activity Two: *The Age of Exploration*

1. Ask students if they can name any famous ocean explorers. *Answers will vary. While individuals like Christopher Columbus or Henry Hudson may be mentioned, the conversation should focus on other explorers like Ferdinand Magellan (the first explorer to sail from the Atlantic Ocean to the Pacific Ocean by sailing around the southern tip of South America) and James Cook (first to cross and explore the Antarctic Circle). Magellan is a Spanish explorer famous for sailing around the southern tip of South America in order to find a way to reach the Pacific Ocean, a task that many explorers before him sought to accomplish. James Cook was a British explorer who scouted Newfoundland and then made several voyages throughout the world's oceans.*

2. Show the students a picture of the Ferdinand Magellan and James Cook voyages from **Reproducible #1**. Tell the students that Ferdinand Magellan had to beg the King of Spain to support and fund his journey. He is also the person responsible for the Pacific Ocean's name. He gave the ocean its name because of its calm waters.[18] While Magellan is often credited with being the first person to sail around the world, he was actually killed in the Philippines (roughly half-way through the journey), and it was his crew that completed the ultimate circumnavigation. Next, tell the class about James Cook who is considered one of the greatest explorers in human history. Though Cook made numerous discoveries and has many accomplishments to his credit, he is best remembered for his contributions to global navigation. He was also able to successfully prevent scurvy by giving his crew citrus fruit and sauerkraut.[19] Scurvy is a disease caused by not consuming enough Vitamin C. (Note: These two explorers have been selected solely for their extra-ordinary feats of navigation. Both contributed greatly to human exploration of the planet, something that remained unparalleled until the modern era. However, their accomplishments do not dismiss the inexcusable acts of injustice carried out by these controversial figures. To learn more about teaching this aspect of the Age of Exploration, please visit the following resource: http://www.educationworld.com/a_curr/curr167.shtml.)

3. Describe the Age of Exploration and discuss the technology that explorers used during that time period. *Unlike today when we use GPSs, satellites and radios, these explorers were traveling in a time before maps were accurate or even existed for many areas. Instead, they used the stars, the sun, and early maps to navigate. Very early ocean explorers could only use the sun and stars to navigate, which made traveling when the sky was cloudy especially treacherous and scary. After a seaworthy compass was invented,*

[18] "Ferdinand Magellan: Spanish Explorer." *Magellan*. Oracle Education Foundation. Web. 3 Mar. 2011. http://library.thinkquest.org/J002678F/magellan.htm.
[19] "Captain James Cook." *Lucidcafé Interactive Café and Information Resource*. Web. 03 Mar. 2011. http://www.lucidcafe.com/library/95oct/jcook.html.

navigation became much easier. Telescopes and sextants were also commonly used tools. The sextant measures distances using two visible objects, such as a star and the horizon. Present a picture of the sextant and telescope from **Reproducible #1**.

4. Briefly talk about how compasses work. Use a hiking compass as an example. Show that it always points north if on a level surface. *Compasses use magnets or polarized pins that spin to align themselves with the axis of the Earth. The Earth is actually a large magnet in which the geographical poles (the Arctic and Antarctic poles) act as the north and south poles of a magnet.*

5. Explain to student that they will be making their own working compasses. Pass out **Reproducible #6 – Making a Compass.** Have students read the instructions aloud and remind them to be careful when working with the paperclips.

6. Follow the directions alongside the students as they perform each step to make the compasses. Make sure to help students if they are having trouble bending the paperclips or pushing them through the cork. If it is too hard to push the paperclips through the cork, you can just place the paperclip on top. If there are not enough hiking compasses for each student to have one for calibration, tell the class that they will need to share the hiking compasses. Make sure everyone has a chance to use it.

7. After students have made their compasses and cleaned up their materials, have them answer the review questions. When most of the students have answered the questions, go over them as a class. Refer to the **Review Questions – Answer Key**.

Activity Three: *Aliens in the Deep*

1. Tell your students that, over time and since the Age of Exploration, the entire surface of the ocean has since been charted. As a result, explorers now go below the surface to investigate new areas. Show students a picture of the ocean zones from **Reproducible #1**. Ask volunteers to point to what they think is the lowest depth that any person has ever traveled to in the ocean.

2. Describe the journey of Jacques Piccard, a French explorer, and Don Walsh, an American naval officer, who used a submarine (bathyscaphe) to travel to a depth of 35,000 feet (6.6 miles), the Hedalpelagic Zone. Show students a picture of the submarine/bathyscaphe that Jacques Piccard and Don Walsh used to travel to 35,000 feet below the surface (also in **Reproducible #1**). Point out that the divers actually were not situated in the middle of the vessel like typical submarines. Instead the observation pod was at the bottom.

3. Use analogies to help students visualize 35,000 feet (about six and a half miles). Compare this distance to other distances students may be familiar with such as the distance from home to school.

4. Jacques Piccard and Don Walsh made their journey in 1960 and ever since then no one has ever met or even come close to that depth with humans as passengers. Why do students think this is the case? *It takes a significant amount of resources to be able to accomplish such a feat. For example, Piccard had the backing of the United States Navy. Nowadays, people may be unwilling to fund*

such a project. The bathyscaphe also had no scientific or observational equipment on it. Tell your students that humans typically do not travel to the lower depths of the ocean because it is so dangerous and expensive. The human body is not designed to survive under water, so even if someone had an infinite amount of air s/he would not be able to dive to the very bottom because the pressure would be too great. Instead, remotely controlled and autonomous robots are used to explore those zones. Students can look at the images of such devices in **Reproducible #1**.

5. Ask students to imagine what life is like in the deeper depths of the ocean. What would they feel/see/hear/experience down there? *Answers will vary, but may include: very cold and dark, strange and unfamiliar, lots of pressure, little food, bioluminescent creatures, big eyes, wide mouths*. What is bioluminescence? *Light produced from living organisms*. Show the picture of the bioluminescent fungi in **Reproducible #1**. Tell students that in the deep ocean, the pressure from all the water is substantial. Ask students if they have ever swam to the bottom of a swimming pool. They might remember feeling more pressure as they swam deeper down. Thousands of feet below the ocean, the pressure is even greater. The combination of pressure and little food means that animals have to conserve energy. As a result, some species will wait for food to come to them or use lures to draw them in. One example is the Anglerfish, a fish that uses a bioluminescence tip to lure prey toward it.[20]

6. Tell the students that you will be doing a short class exercise exploring such creatures of the deep. Take out **Reproducible #7 – Aliens in the Deep** and tell your class that you will be reading a short description of an animal that might be found in the deep ocean. Then, they will have to decide as a class whether or not the animal described is real. After they decide, reveal whether or not the animal actually does exist. If it does exist, give its name, show its pictures and say where in the ocean it is found.

7. Pass out **Reproducible #8 – Create–a–Creature.** Ask your students to imagine some other creatures that they might find at the bottom of the ocean. Remind them of the living conditions in the deep sea. Then, ask them to draw a picture of their own deep sea creatures. Tell them to be as creative as they want! For older students (3rd and 4th grade), have them write short descriptions of the creatures' anatomy using arrows to point to the described body parts.

8. When all the students have completed their drawings of deep sea creatures, have them present their creatures to the rest of the class one at a time. Ask them to describe why they chose to draw the creatures the way they did. Post the pictures on a wall in the classroom or in a hallway at the end of the day.

Wrap Up: *Discussion*

1. Why do you think it is important to explore the ocean? *Humans have learned, and continue to learn, many new discoveries from exploring the ocean. The ocean holds the key to solving many scientific mysteries. For example, there are many species in the ocean that have not been discovered yet. Some of these*

[20] "Anglerfish, Anglerfish Facts - National Geographic." *Animals, Animal Pictures, Wild Animal Facts - National Geographic.* Web. 03 Mar. 2011. http://animals.nationalgeographic.com/animals/fish/anglerfish.

species may be the solution to curing certain diseases or providing vaccines. Additionally, species that we thought were extinct may still exist in the ocean, and if we find these species, we may be able to learn more about prehistoric life. Learning about such species can also teach us about how life is able to survive in hostile conditions. Until recently, scientists believed that plants need sunlight to survive, but scientists have found whole ecosystems in the parts of the bottom of the ocean where there is no light. The plant life seemed to survive from chemicals produced by geologic vents in the earth. Findings like this help to challenge preconceptions about how the world works, and it teaches us more about the varieties of life.

2. How do you think people will be exploring the ocean in the future? *Answers will vary. Possible answer: with special marine suits that allow people to travel to the ocean depths, underwater cars/buggies that drive along the bottom of the ocean, build suspended, underwater marine laboratories where scientists can research the ocean for months at a time, like the International Space Station.*

3. If you had the choice of going into space or going to the bottom of the ocean, which would you choose? Why? *Answers will vary.*

Extension Activities:

1. If your school has access to computers with Google Earth installed, take your students to the computer lab and allow them to track famous ocean expeditions, such as the Ferdinand Magellan voyage around the world[21] or James Cook's first voyage.[22]

2. If your school has access to computers with Google Earth Ocean, take your students to the computer lab and allow them to explore the depths of the sea. This application allows students to visit the deepest parts of the Ocean. Ask students to write an essay about what they find.

3. Have students research a deep sea creature to discover their peculiarities. Does that sea creature offer any benefits to people?

4. Compare and contrast space exploration to ocean exploration. How are they similar and different? Which has more left to explore? Why?

CONCLUSION

This lesson taught students about how ocean exploration has changed throughout history. Students were first introduced to the ways early humans traveled across oceans. Then, they investigated the Age of Exploration, and the tools invented that enabled European explorers to make longer journeys. Students built compasses to help understand the evolution of geographical tools. Finally, students learned about the modern era of ocean exploration during which people dove beneath the surface of the ocean to further explore the depths and life at the bottom of the sea.

---

[21] Frey, Wendy. *History Alive! The Medieval World and Beyond.* Palo Alto, CA, 2005. Retrieved March 6 2011 from http://csmh.pbworks.com/w/page/7309501/1519%20-%20Ferdinand%20Magellan.

[22] "Cook's Three Voyages." Extended Definition: James Cook. Webster Online Dictionary. Retrieved March 2 2011 from http://www.websters-online-dictionary.org/definitions/James%20Cook?cx=partner-pub-0939450753529744:v0qd01-tdlq&cof=FORID:9&ie=UTF-8&q=James%20Cook&sa=Search#874.

LESSON PLAN CREDITS

Wesley Tse – Author
Education Intern, Earth Day Network
Maggie Ollove – Editor
Education Associate, Earth Day Network

Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org

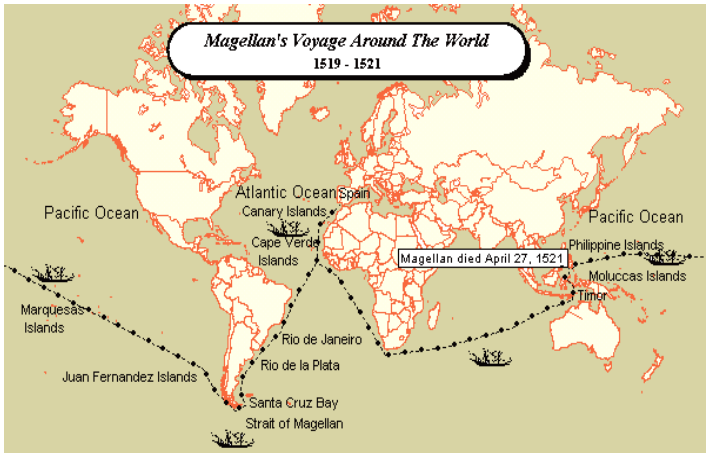
EXPLORATION PICTURES

SUBMARINE[23]

[23] Bremerhaven U-Boot-Museum-Sicherlich, 2007. retrieved March 4 2011 from http://en.wikipedia.org/wiki/File:2004-Bremerhaven_U-Boot-Museum-Sicherlich_retouched.jpg.

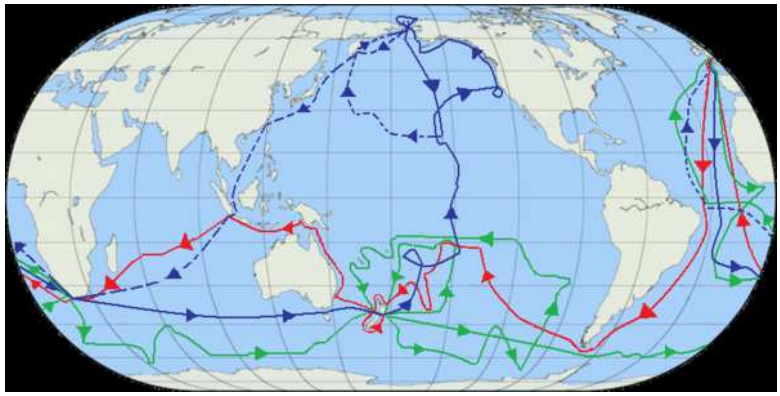
FERDINAND MAGELLAN[24]

MAGELLAN'S VOYAGE[25]



JAMES COOK[26]

COOK'S THREE VOYAGES[27]

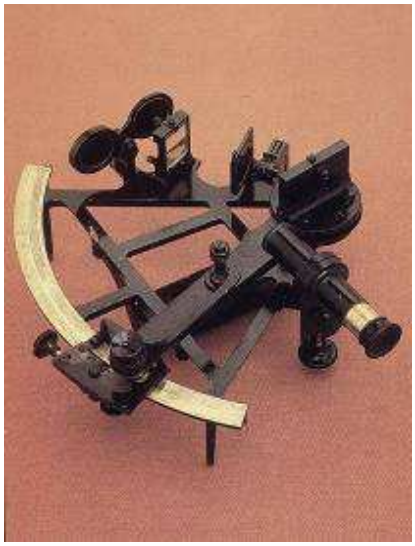


COOK'S FIRST VOYAGE IS IN **RED**, HIS SECOND VOYAGE IS IN **GREEN** AND THE THIRD IS IN **BLUE**. THE DASHED BLUE LINE CONTINUES THE ROUTE HIS CREW TOOK AFTER HE DIES IN 1779.

---

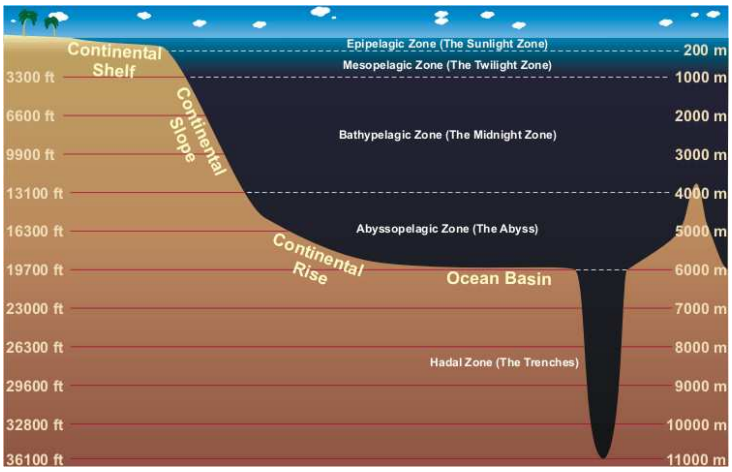
[24] Ferdinand Magellan. *Museo Naval de Madrid*, Oil on Canvas. 1787. Retrieved March 6 2011 from http://en.wikipedia.org/wiki/File:Hernando_de_Magallanes_del_museo_Madrid.jpg.
[25] Frey, Wendy. *History Alive! The Medieval World and Beyond.* Palo Alto, CA, 2005. Retrieved March 6 2011 from http://csmh.pbworks.com/w/page/7309501/1519%20-%20Ferdinand%20Magellan.
[26] Dance, Nathaniel. "James Cook." *National Maritime Museum.* United Kingdom, 1776. Retrieved March 2 2011 from http://www.nmm.ac.uk.
[27] "Cook's Three Voyages." Extended Definition: James Cook. Webster Online Dictionary. Retrieved March 2 2011 from http://www.websters-online-dictionary.org/definitions/James%20Cook?cx=partner-pub-0939450753529744:v0qd01-tdlq&cof=FORID:9&ie=UTF-8&q=James%20Cook&sa=Search#874.

SEXTANT[28]

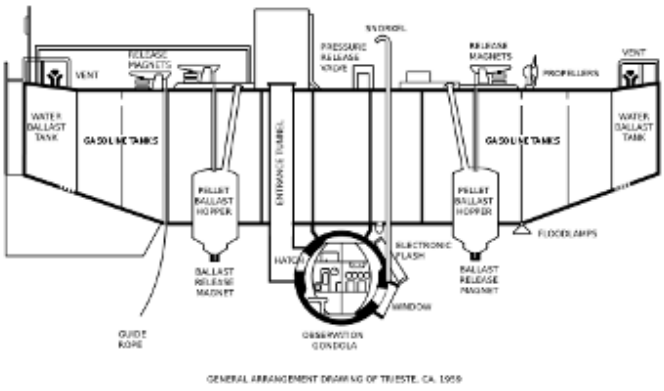


TELESCOPE[29]

OCEAN ZONES[30]



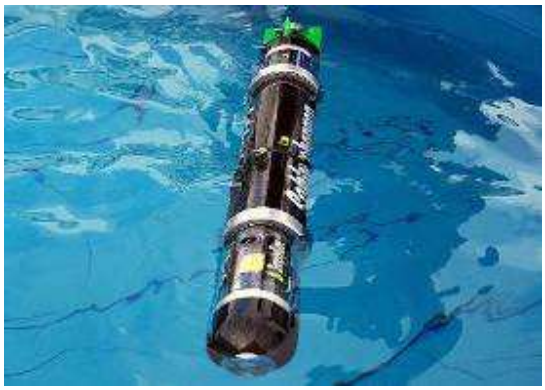
BATHYSCAPHE[31]



[28] "Sextant." *National Oceanic and Atmospheric Administration Photo Library.* Retrieved March 3 2011 from http://www.photolib.noaa.gov/htmls/theb2176.htm.
[29] "Portable Telescope." *National Maritime Museum.* United Kingdom, 1661. Retrieved March 2 2011 from http://www.nmm.ac.uk/blogs/collections/objects/telescopes/.
[30] "Profile of the Ocean." *National Weather Service.* National Oceanic and Atmospheric Administration. Retrieved March 4 2011 from http://www.srh.noaa.gov/jetstream/ocean/oceanprofile.htm.
[31] "Scale Drawing of Bathyscaphe Trieste." *U.S. Naval Historical Center.* 1960. Retrieved March 4 2011 from http://www.history.navy.mil/photos/images/h96000/h96807.jpg.

ROV (REMOTELY OPERATED VEHICLE)[32]

UNDERWATER AUV (AUTONOMOUS UNDERWATER VEHICLE)[33]



BIOLUMINESCENCE[34]

[32] Mierlo, Frank van. "ROV (Remotely Operated Underwater Vehicle)," 2006. Retrieved March 7 2011 from http://en.wikipedia.org/wiki/File:ROV_working_on_a_subsea_structure.jpg.
[33] Esparon, Smith, Shah and Nickels, Dr. Timothy. "AUV (Autonomous Underwater Vehicle)." *University of Cambridge Department of Engineering*, 2008. Retrieved March 2 2011 from http://www.eng.cam.ac.uk/photocomp/2009.
[34] Ylem. "The saprobe Panellus stipticus displaying bioluminescence." August 2009. Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:PanellusStipticusAug12_2009.jpg.

OCEANIA LOCATIONS/STATION DESCRIPTIONS

Directions for Teacher: Print out and place these descriptions along with example pictures at their respective stations.

Indonesia[35]

The Indonesia region is comprised of more than seventeen thousand small islands. Situated southeast of mainland Asia, Indonesia lies right on the **equator**, so it has a hot climate. The average monthly high temperature is in the 90s on the Fahrenheit scale. This country has two seasons, wet and dry. During the wet season, there is a considerable of rain. During the dry season, it does not rain very much at all.

Like many Pacific islands, Indonesia has many **volcanoes** and some of them are still **active**! Indonesia has a variety of different **ecosystems** including beaches, sand dunes, coral reefs and tropical forests. These **ecosystems** are home to a mix of animals such as the orangutan, tiger, and incredible plants, such as the Monster Flower.

Clue #2: The next location is both a country and a continent where you will find kangaroos.

[35] Screenshot from NASA World Wind, Blue Marble Next-Generation layer. "Satellite image of Indonesia in August 2004." Retrieved on March 2 2011 from http://commons.wikimedia.org/wiki/File:Indonesia_BMNG.png.

Sumatran Orangutan[36]

Sumatran Tiger[37]

Monster Flower[38]

[36] Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Man_of_the_woods.JPG.
[37]Herbert, Captain. "Sumatran tiger in the Tierpark Berlin." October 17 2009. Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Sumatran_Tiger_Berlin_Tierpark.jpg.
[38]Polak, Klaus. "Rafflesia kerrii Meijer." December, 2003. Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Rafflesia_kerrii_flower.jpg.

Australia[39]

Australia is country with three million square miles – about the same size as the United States. It has the sixth largest amount of land of any nation in the world. It is the only nation to govern an entire continent.

Since Australia is so large, it has many different **climates**. Australia is the second driest continent on Earth after Antarctica. The middle of Australia is known as the "Outback" and is mostly desert land with hot, dry weather. The weather on the coast is cooler with more rain but still sees high temperatures.

Australia has a wide variety of plants and animals that are not found in other places of the world. The Great Barrier Reef, the world's largest coral reef, is right off the northeastern coast. Many different marine plants and animals, including sea turtles, dolphins, whales, porpoises, and many different kinds of fish depend on the Great Barrier Reef for a home. In terms of mammals, Australia is famous for its koalas, kangaroos, dingoes and wombats. Some of its recognizable birds include the emu and kookaburra. The eucalyptus is a type of fast-growing tree that dominates the Australian landscape and provides a steady supply of wood. The oil from the eucalyptus tree is a useful, natural insecticide.

Can you imagine what explorers would see if they came ashore? There would be large mammals running and hopping about, **rainforests** and tropical plants and a large amount of land.

Clue #3: The next location is directly north of Australia. On this island, rainfall can sometimes reach 400 inches per year!

[39] Screenshot from NASA World Wind, Blue Marble Next-Generation layer. "Australia in orthographic projection." Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Australia_satellite_orthographic.jpg.

Wombat[40]

Eucalyptus Tree[41]

Emu[42]

[40] Harrison, JJ. "Vombatus Ursinus." November 29, 2009. Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Vombatus_ursinus_-Maria_Island_National_Park.jpg.
[41] Taylor, T. "Tasmania Logging Mighty Tree." Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Tasmania_logging_08_Mighty_tree.jpg.
[42] Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Emu-wild.jpg.

New Guinea[43]

Directly north of Australia is the island of New Guinea. When explorers landed on this land, the first thing they would notice is the dramatic land features of New Guinea. New Guinea has large, rough mountains as well as tropical **rainforests** and **wetland** areas.

Just like Indonesia, New Guinea also has several **active volcanoes**. It also sometimes experiences earthquakes and tsunamis.

In some parts of New Guinea, it rains an incredible amount. It can rain as much as 400 inches per year! That's 33 feet per year. Over one year's time, New Guinea gets as much rain as if 7 kids from an average class stood on top of each other. Along the coastline of New Guinea, the **climate** is tropical and weather can be hot. In the land in the middle, the climate is slightly cooler and occasionally it even snows. This is very unusual for an island located so close to the **equator**.

New Guinea's plant and animal **species** are diverse and unique. Scientists estimate over 200,000 species of insects, more than 11,000 **species** of plants and over 650 bird **species** live in New Guinea. The birds include bowerbirds, parrots and cassowaries. Some of the mammals in New Guinea are wallabies, tree-kangaroos and possums. New Guinea is also host to many different plants. Its tropical rainforest areas contain a variety of conifers and tree ferns. New Guinea also has many relics of the past. It is home to many trees typical of the pre-historic time, such as the ant long-beaked echidna.

Clue #4: The next location is a group of islands directly east of New Guinea which is mostly covered by rainforests. In these rain forests, one will find orchids and other types of tropical flowers.

[43] Screenshot from NASA World Wind, Blue Marble Next-Generation layer. Retrieved from http://commons.wikimedia.org/wiki/File:PapuaNG.png.

Cassowary[44]

Tree Kangaroo[45]

Tree Ferns[46]

Echidna[47]

[44] Hamlin, Scott. "Casuarius cauarius." April 18 2007. Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Dendrolagus_goodfellowi_-Melbourne_Zoo,_Australia-8a.jpg.
[45] Ashurst, Richard. " Dendrolagus goodfellowi." June 26 2010. Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Casuarius_casuarius_-Brevard_Zoo-8a.jpg.
[46] "Tree Ferns, 2005." Retrieved March 5 2011 from http://commons.wikimedia.org/wiki/File:Ferns.jpg.
[47] "Short-beaked Echidna, Tasmania," 2006. Retrieved March 8 2011 from http://commons.wikimedia.org/wiki/File:Short-beaked_Echidna_Tasmania.jpg.

Solomon Islands[49]

The Solomon Islands are a group of islands east of New Guinea in the Pacific Ocean. Another name for a group of islands in the ocean is an **archipelago**. Since these islands are close to the equator, the **climate** is tropical and humid throughout the year. It can be very hot! It also rains about 120 inches per year.

The Solomon Islands are very diverse. Some of the islands have large mountains on them and fast-flowing rivers, while others are tiny coral islands in the middle of lagoons. Much of the Solomon Islands are covered by **rainforest**. Because there is so much rain, this makes excellent conditions for many types of tropical plants, including beautiful orchids. These islands also house many varieties of birds and butterflies.

These islands also have several **active** and **dormant volcanoes**.

Clue #5: The next location is a group of islands with an unusual name that may be hard to pronounce. It has many volcanoes, some of which are underwater! There is also the flowerpot snake, which is a snake that looks like a worm!

Orchid[50]

[49] Lounsbury, Jim. "Solomon Isles." Retrieved March 2 2011 from http://commons.wikimedia.org/wiki/File:Solomon_Isles.jpg.
[50] "White Orchid 2005." Retrieved March 4 2011 from http://en.wikipedia.org/wiki/File:White_Orchid.jpg.

Vanuatu[51]

Vanuatu is a group of islands located southeast of the Solomon Islands. Like many islands in the Pacific Ocean, Vanuatu includes a number of **volcanoes**, some of them underwater! Vanuatu also experiences many earthquakes. What would explorers think of coming to this island with **volcanoes** *and* earthquakes?

These islands do not have many plants or animal species. How would the explorers have felt to come to this island with few plants and animals? Was this a good place to find resources? One of the few animals that can be found in Vanuatu is flowerpot snake. This snake is small and people often mistake it for a worm. Another fascinating feature of this place is the giant banyan trees. These trees are one of the world's largest living organisms. They can grow to be the size of a soccer field!

Additionally, the **climate** is very hot, which promotes the growth of tropical forests. Daily temperature in Vanuatu ranges from high 60s to low 90s Fahrenheit. Vanuatu gets a lot of rain – about 93 inches a year. Even though it has few native animals and plants, Vanuatu does have many waterfalls and beautiful beaches.

Clue #6: Much of this next location is made up of wetland features, including swamps and lagoons.

[51] "Vanuatu." *The World Factbook*. Central Intelligence Agency. Retrieved March 5, 2011 from https://www.cia.gov/library/publications/the-world-factbook/geos/nh.html.

Banyan Tree[52]

Flowerpot Snake[53]

Grande Terre Island[54]

[52] Banyan Tree, 2007. Retrieved March 8 2011 from http://commons.wikimedia.org/wiki/File:Banyan_tree_Old_Lee_County_Courthouse.jpg.
[53] "Blind Minute Snake 2004." Retrieved March 3 2011 from http://upload.wikimedia.org/wikipedia/commons/5/53/Ramphotyphlops_braminus_jja.jpg.
[54] Vanuatu Tanna Yasur, 2006. Retrieved March 3 2011 from http://upload.wikimedia.org/wikipedia/commons/2/20/Vanuatu_Tanna_Yasur.JPG.

New Caledonia[55]

New Caledonia is a region consisting of one large island and many smaller islands. The largest island, Grande Terre, is the only mountainous island. All of the islands have many lakes and rivers and various **wetland** geographical features, including swamps, grasslands and even lagoons. In fact, New Caledonia is home to the world's largest enclosed lagoon with canyons and caves, coral, tropical fish, turtles sea snakes, and sharks.

New Caledonia is further from the **equator** from the other islands we have explored, so the temperature does not get as hot and has a nice breeze. Unlike Vanuatu, life on New Caledonia is diverse and unique to the islands. Interesting species such as the Kagu bird and the Rousette – a vegetarian bat – call New Caledonia their home. One of the plants on New Caledonia is the Cook's Pine.

Clue #7: The next location is a group of 322 islands, but the greatest area is contained within just two main islands.

Kagu Bird[57]

Cook's Pine[56]

[55] "Baie des Tortues 2006." Retrieved March 1 2011 from http://upload.wikimedia.org/wikipedia/commons/thumb/0/02/201_au_28_-07-2004_553.jpg/800px-201_au_28_-07-2004_553.jpg.

[56] *"Araucaria columnaris* in Giardino dei Semplici di Firenze," 2007. Retrieved March 2 2011 from http://upload.wikimedia.org/wikipedia/commons/9/9c/Araucaria_columnaris_01_by_Line1.jpg.

[57] Meyer, Scott. "Kagu Bird, 2004." Retrieved March 3 2011 from http://upload.wikimedia.org/wikipedia/commons/8/87/Rhynochetos_jubatus.jpg.

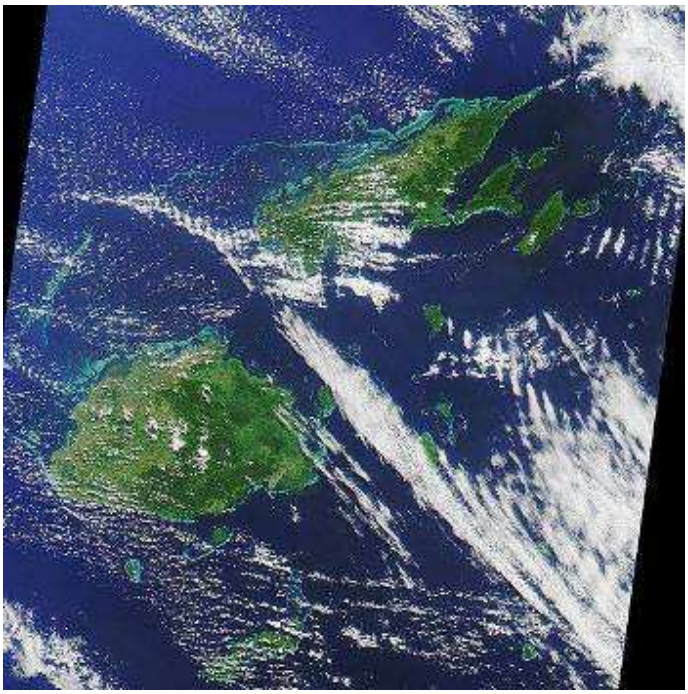
Fiji[58]

The **archipelago** (group of islands) of Fiji is located in the southwestern Pacific Ocean. It contains 322 islands and 522 smaller islands, called islets, but two of the islands account for most of the country's total land area. Also, because of the lack of fresh water available, people live on only 106 of these islands.

Fiji's islands are mountainous and covered in tropical forests. This region has a tropical marine **climate** and is warm most of the year. During the warmer season, Fiji experiences considerable rain. Wind is moderate for most of the year but sometimes cyclones do happen.

Clue #8: Your next step will actually take you to two different locations:

1. **This next group of islands eventually became the fiftieth US state. In this location, one will also find the happy face spider.**
2. **The other location is southeast of Australia. The land in this location includes fiord land, glaciers, mountains, rainforests and volcanoes. You will also find kiwi birds here.**



[58] "Fiji." *National Aeronautics and Space Administration.* Retrieved March 3 2011 from http://earthobservatory.nasa.gov/IOTD/view.php?id=46954.

Hawaii[59]

Hawaii was not always a state in the United States of America. Before it was a part of the United States, it was inhabited for generations by an independent kingdom, and before human arrival, it was a remote group of islands in the northern central Pacific. First settled by Polynesians between AD 300 and 600, Captain James Cook visited Hawaii in 1778 and called the group of islands the Sandwich Islands.

All of Hawaii's islands were formed by **volcanoes**. As a result, Hawaii is fairly mountainous. Its **climate** is considered tropical. Temperatures hover around the mid 70s to upper 80s Fahrenheit during the summer and 60s to mid 80s in the winter. At the highest points of some of the islands, it occasionally snows.

Given its isolated location, Hawaii has a very unique collection of **species**. Some of the animals found on these islands include the Hawaiian goose and the happy face spider. The Loulu palm tree is a plant native to Hawaii.

Congratulations! You have reached your destination. There is no clue for this location.

[59] "Hawaiian Islands." *Earth Observatory*. National Aeronautics and Space Administration. Retrieved March 5 2011 from http://upload.wikimedia.org/wikipedia/commons/6/6b/Hawaje-NoRedLine.jpg.

Hawaiian Goose[60]

Happy Face Spider[61]

Loulu[62]

[60] Zaun, Brenda. *Kilauea Point and Nene*. 2005. Photograph. U.S. Fish and Wildlife Service Headquarters, Kilauea Point, HI. *Flickr*. Flickr. Web. 4 Mar. 2011. http://www.flickr.com/photos/usfwshq/5121523226.
[61] Theridion grallator, 2010. retrieved March 4 2011 from http://en.wikipedia.org/wiki/File:Theridion_grallator.jpg.
[62] "Huelo Islet, Relict of Prehistoric Lowland Forests." *Kalaupapa National Historical Park*. National Park Service. Web. 4 Mar. 2011. http://www.nps.gov/kala/naturescience/louluforest.htm.

New Zealand[63]

The New Zealand island group is a series of Pacific Ocean islands found off the southeast corner of Australia. The first people to inhabit this land are known as Maori. They named this land, Aotearoa – the Land of the Long White Cloud. It was not until later that it became known as New Zealand.

Aotearoa or New Zealand consists of two large, main islands and a number of smaller islands. The main islands are very large and skinny. The top of the North Island has warm, subtropical weather, while the bottom of the South Island is one of the closest landmasses to Antarctica. The entire area of New Zealand is about one third the size of California.

New Zealand has many mountains and **dormant volcanoes**, forests, fjords, glaciers, rainforest, plains and beaches. Unlike many of the other island groups in the Pacific Ocean, New Zealand's southern location gives it a mild and temperate **climate** - so it does not get too hot or too cold. Temperature varies widely throughout the year; the maximum temperature recorded is 108° Fahrenheit and the minimum is -9.6° Fahrenheit. Rainfall is also much less than in other Pacific Ocean regions, approximately 25 inches per year.

Plants and animals in New Zealand include the eccentric looking Kiwi bird, the familiar gecko and the large Kauri tree. These trees number among the oldest trees in the world, and are also the biggest in girth. New Zealand's only native mammals are three different kinds of bats.

Congratulations! You have reached your destination. There is no clue for this location.

[63] "New Zealand : Image of the Day." *NASA Earth Observatory: Home*. NASA, 7 Jan. 2003. Web. 04 Mar. 2011. http://earthobservatory.nasa.gov/IOTD/view.php?id=3101.

Kiwi Bird[64]

Gecko[65]

Kauri[66]

[64] Elusive Kiwi, Selwyn Heights, Rotorua, NZ. 2010 http://www.flickr.com/photos/30705804@N05/4725940989.
[65] Phelsuma l. laticauda, 2005. retrieved March 4 2011 from http://en.wikipedia.org/wiki/File:Phelsuma_l._laticauda.jpg.
[66] Tane mahuta, 2005. retrieved March 4 2011 from http://en.wikipedia.org/wiki/File:Tane_mahuta.JPG.

Voyage Vocabulary

These are a few vocabulary words to help inform your journey.

Archipelago: A large group or chain of islands.

Climate: The normal weather conditions of a region; the temperature, amount of air pressure, humidity, rain, sunshine, cloudiness and wind over a year.

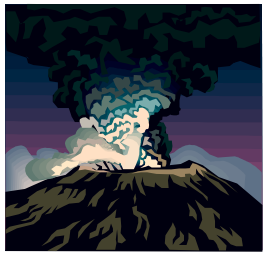
Ecosystem: The plants and animals that are found in a particular location. These plants and animals depend on each other to survive.

Equator: The equator is an imaginary line between the northern and Southern hemispheres. Most places along the equator have a constant temperature and amount of sunlight, it's usually very warm.

A tropical forest with many, tall evergreen trees (trees that keep their leaves year round) in an area where it rains a lot.

Species: A class of individuals having common attributes and designated by a common name (e.g., humans, dogs, dolphin, spiders, etc.).

Volcano: A volcano is a mountain that opens downwards to a pool of molten rock below the surface. When pressure builds up, eruptions occur. Gases and rock shoot up through the opening and spill over or fill the air with lava fragments. An **ACTIVE VOLCANO** is a volcano that has erupted recently and will erupt again. A **DORMANT VOLCANO** is a volcano that is not currently active but may be again one day.



Wetland: Land that has a wet and spongy soil, as a marsh, swamp or blog.

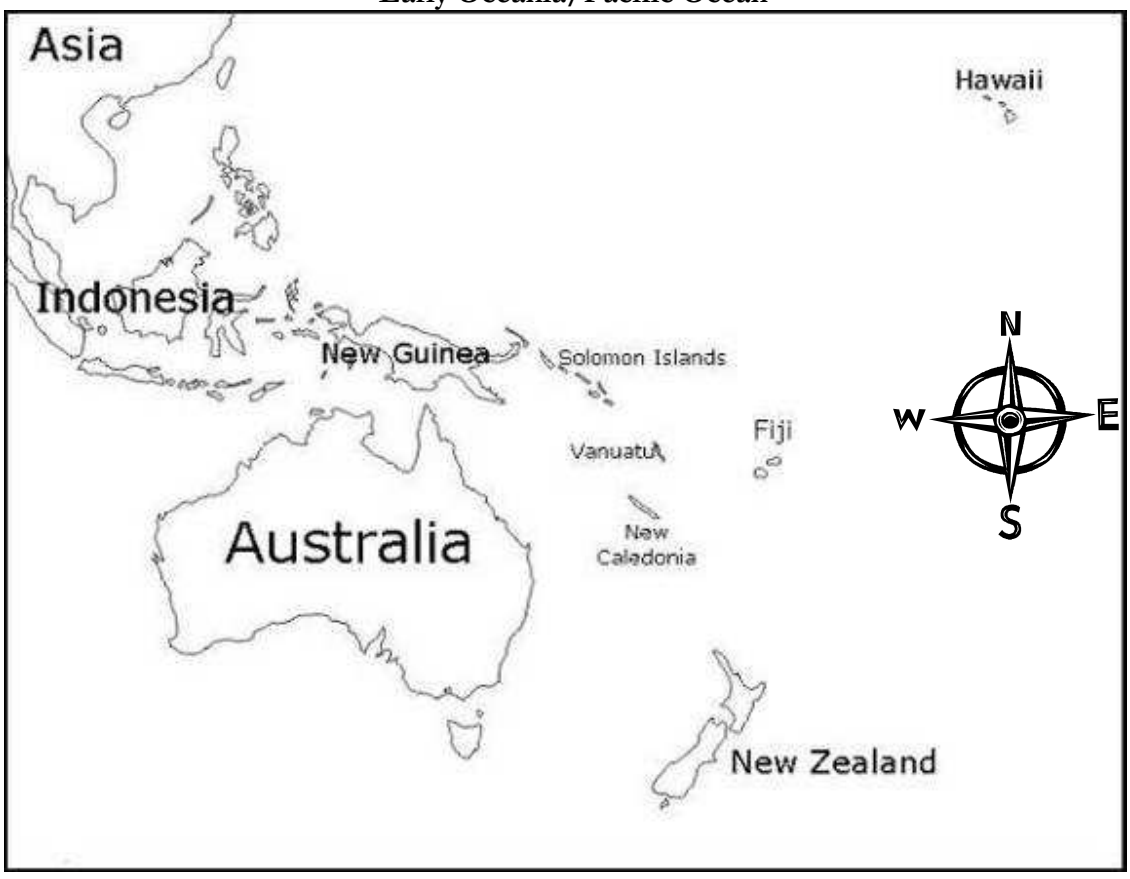
Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org

Island Hopping Across the Pacific

Imagine you are a Pacific Islander during early human history. As your civilization expands, you are forced to search for new land to find more resources, such as food and drinking water. Starting in mainland Asia, make your way across the Pacific Ocean by traveling from location to location. Around the classroom (or school) are different stations, each representing a different region or cluster of islands. Plot your migration path by visiting the stations and reading the **description** and **clue** at each location. You will use the clue to decide which location to go to next. **The goal is to recreate the same path that early human likely used to travel across the Pacific.** Your path should include each location **only once**. Then write out the order in the numbered list and answer the questions. When you are done, you may color in the map. At the end of the activity, we will compare our paths and the teacher will reveal the *most likely* path that was really used. Start in the middle of the classroom (Asia) and read **CLUE #1** to find your first location.

CLUE #1: Your first destination is a large group of islands directly southeast of mainland Asia. It is the home of the Sumatran Tiger.

Early Oceania/Pacific Ocean



Possible Locations:

~~Asia~~	Indonesia	New Guinea	Australia
Solomon Islands	Vanuatu	New Caledonia	Fiji
New Zealand	Hawaii		

Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org

Order of Migration

1) Hong Kong, China
2) _____
3) _____
4) _____
5) _____
6) _____
7) _____
8) _____
9) _____ /_____

Questions:

1. Why did you choose the path that you did?

_____

_____

_____

2. Why do you think the last step includes two different locations?

_____

_____

_____

3. Imagine you are a historian or archaeologist trying to track the migration path across the Pacific Ocean. What sort of clues would you look for?

_____

_____

_____

4. Most historians and archaeologists do not agree on the exact path of migration across the Pacific Ocean. Why do you think this is?

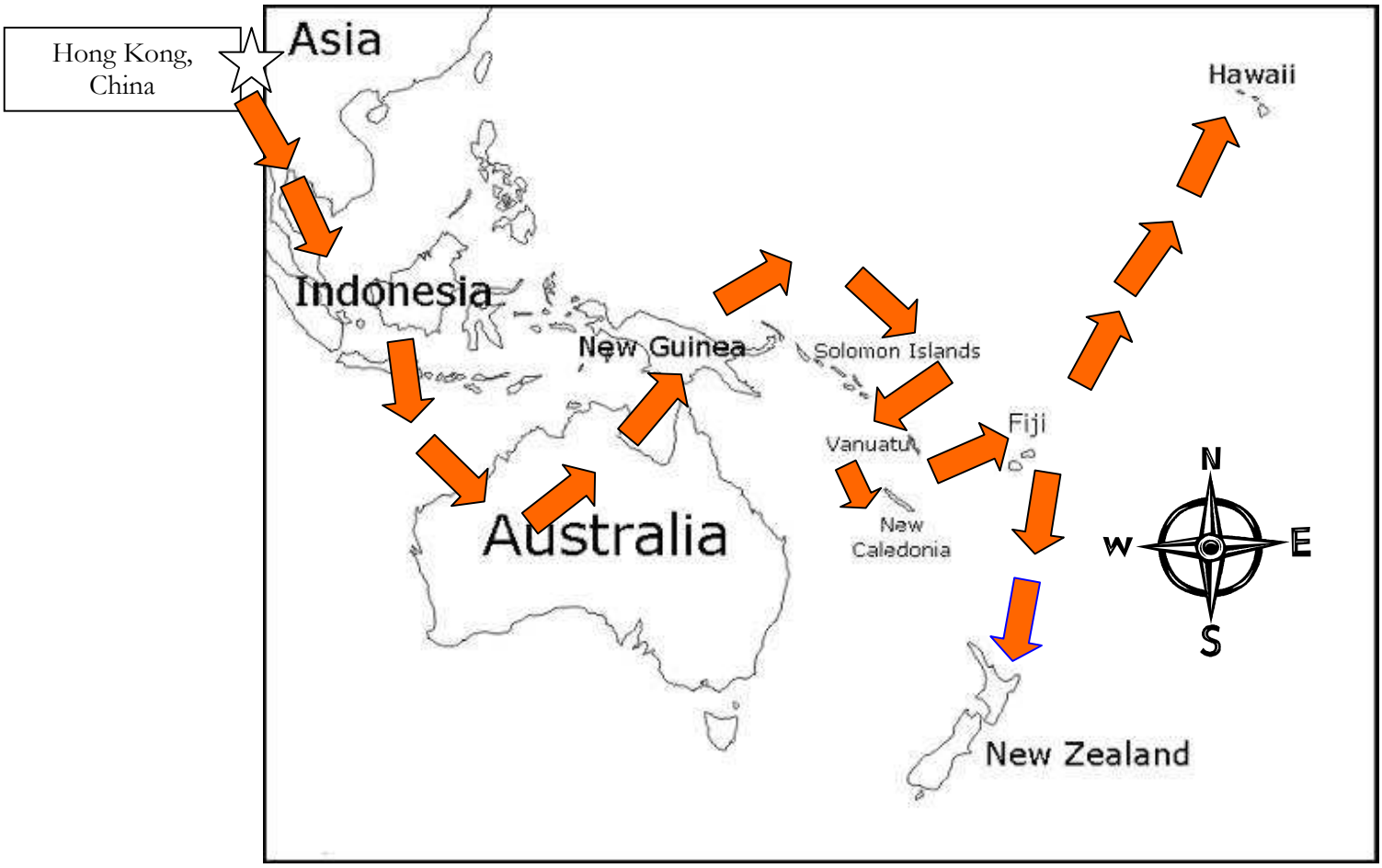
_____

_____

_____

ACTUAL PATH OF PACIFIC ISLANDERS

Asia ► Indonesia ► Australia ► New Guinea ► Solomon Islands ► Vanuatu ► New Caledonia ► Fiji ► Hawaii AND New Zealand



Answers to Questions

1. What did you choose the path that you did? *Answers will vary.*
2. Why do you think the last step includes two different locations? *The previous islands were close enough that there was a clear path from west to east. However, New Zealand and Hawaii are remote and far apart from each other. Subsequently, people would likely not travel to New Zealand first, then Hawaii or vice versa.*
3. Imagine you are a historian or archaeologist trying to track the migration path across the Pacific Ocean. What sort of clues would you look for? *Tools, building remains, bones, art, etc. Anything that would signify the presence of people.*
4. Most historians and archaeologists do not agree on the exact path of migration across the Pacific Ocean. Why do you think this is? *It is difficult to date much of the archaeological evidence that has been found. It is also difficult to determine if people followed the same path or if separate groups reached the same islands by different paths, etc.*

Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org

MAKING A COMPASS

WARNINGS

Teacher should monitor the preparation and usage of paperclips so that no one injures themselves when unwinding the paper clip or pushing it through the cork. Teacher may want to perform this task prior to commencement of this activity.

DO NOT rub the magnet against electronic equipment; this may hamper its abilities.

MATERIALS

1 paperclip
1 cork piece
1 magnet
1 colored marker
1 cup
1 hiking compass (shared by class)

INSTRUCTIONS

1. Unwind the paperclip so that it is straight. It does not have to be perfectly straight! Be careful not to poke yourself (the teacher may perform this task, as needed, prior to class). If you do need help, ask the teacher.
2. Take the magnet and rub one pole of it along the paperclip 10-20 times. Make sure to rub the paperclip in the **same direction**. By doing this you are magnetizing the paperclip. After you've rubbed the paperclip, you can try bringing the magnetized end close to other metal surfaces to see if it will attract.
3. Push the paperclip through the cork piece so that both ends of the paperclip are exposed. Be careful with the paperclip. If you need help, ask the teacher. You may also simply rest the paperclip on top of the cork.
4. Fill the cup with water, and place the paperclip and cork in the cup. Wait for the paperclip to stop spinning. After it has stopped, compare the alignment of the paperclip with the hiking compass. They should be facing the same way. If not, re-magnetize the paperclip with the magnet.
5. Note the direction that the north tip of the hiking compass faces, and mark that same end of the paperclip with the marker. The marked end will always point north.
6. Congratulations, you just made your own compass!

Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org

REVIEW QUESTIONS

1. What happened to the paperclip and cork when you placed it in the water?

_____

_____

_____

2. Why do you think this happens?

_____

_____

_____

3. Sailors did not use compasses on boats until about 1190. Why do you think this is?

_____

_____

_____

Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org

REVIEW QUESTIONS – ANSWER KEY

1. What happened to the paperclip and cork when you placed it in the water?

If the paperclip was properly magnetized, it would have attempted to spin, turning the cork with it, so its ends align with the Earth's axis.

2. Why do you think this happens?

The paperclip acts like a magnet and is influenced by the Earth's magnetic field. Since it is floating on the water, it is allowed to spin freely. As a result, it will align in an "opposites attract" fashion: north to south, south to north.

Going more in-depth, since the magnet was rubbed against the paperclip, its electrons were rearranged to face a certain way, subsequently turning it into a weak magnet. The water acts as a frictionless surface on which the magnetized paperclip can turn relatively freely. As a result, it will align itself so its ends are facing the Earth's poles in a parallel opposite arrangement. The north end of the magnet faces the Earth's magnetic south end (which is actually in the Arctic) and the south end faces the Earth's magnetic north end (which is in the Antarctic).

3. Sailors did not use compasses on boats until about 1190. Why do you think this is?

The idea for a compass has existed for many years. Archaeological evidence suggests that the Ancient Chinese understood the concept of magnetism as early as 2637 BCE, so it is likely that simple compasses like this were made long before 1190. Unfortunately, this type of compass would not be useful on a boat. Rough waves would cause water in the compass to spill out. Additionally, the smallest bump would cause the magnetized needle to become misaligned. Because it takes a while for the needle to realign itself, the compass would not be very accurate. It was not until explorers invented a compass that could quickly realign itself and stay accurate that compasses became more common on ships.

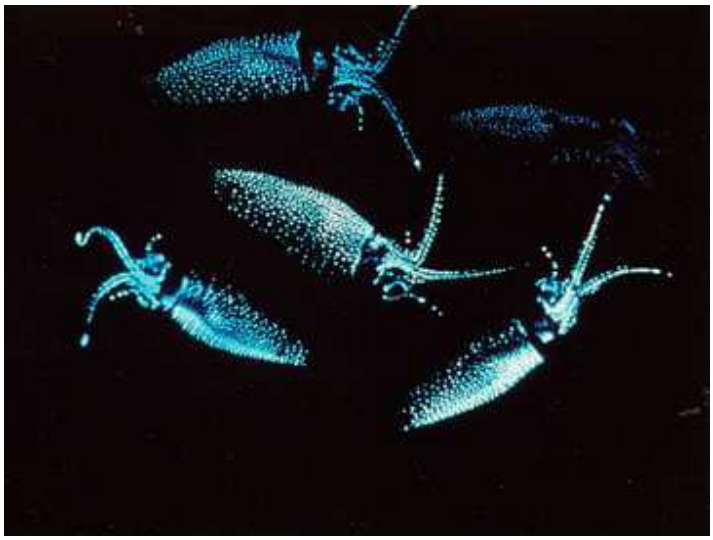
Aliens of the Deep

Directions (for teacher): Choose an animal at random from one of the columns and read its description **without** revealing its name, where it is found or its picture. Then, ask your students if they believe the animal is real or if it is fictional. After the class has come to a consensus, say whether or not the species is real. If the species is real, give its name, provide pictures and describe where it lives in the ocean.

Real	Fictional
Firefly Squid (Western Pacific ocean; 600-1200 feet): This mysterious creature is known for its brilliant bioluminescence. Every year, millions of these small squid gather along the coast of Japan to spawn and present an amazing light show. **Snipe Eel** (Worldwide; down to 6,000 feet): Strange is an understatement for this eel's description. Imagine a piece of rope with a head and bulbous eyes, and you would be thinking of this odd-looking sea creature. They catch shrimp by swimming with their mouth open until their teeth snag on shrimp antennae. **Oarfish** (Mediterranean & East Atlantic; down to 3,000 feet): Some people believe these massive fish are the cause of several sea monster myths. Growing up to 50 feet in length and sporting a red dorsal fin, it is not surprising that people would mistake this fish as a mythical beast. **Giant Isopod** (Worldwide; over 2,000 feet): Anyone who says that bugs don't live in the ocean has never seen this species. Think of what pill bugs look like. That is what these creatures look like, except much bigger. Their eyes are specially designed to have a wide field of view and be sensitive to fast movements.	**Clawfish**: Appropriately named for its claw-shaped mouth, this large fish devours its prey by clamping down with its strong, toothed jaws. It eats small fish, jellyfish and sometimes crabs. **Sonar Eel**: Like dolphins, these eels use echolocation, or signals of sound, to find their food. However, since they lack eyes, a nose or ears, echolocation is their primary method for navigating the ocean depths. **Paper Shrimp**: These shrimp are so thin that even if you were able to go deep enough in the ocean to where they live, you would probably never see them. Viewed head on, they are barely visible. These marine animals developed this unique trait over many years to avoid detection from predators. **Wheeler Octopuses**: Considered to be the smallest octopuses ever to exist, these seven inch diameter creatures are famous for their signature wheeling motion, in which they spread out their arms and quickly spin in a circle. Not only is this used as an escape mechanism, but it can also paralyze or kill smaller fish.

Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org

Firefly Squid[67] [68]

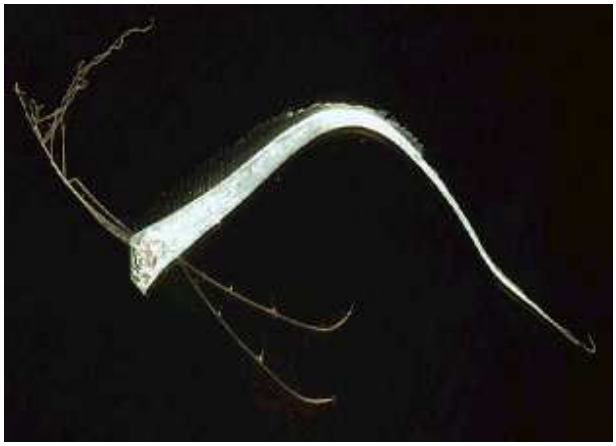


Snipe Eel[69] [70]

---

[67] Watasenia scintillans, 2008. retrieved March 4 2011 from http://en.wikipedia.org/wiki/File:Watasenia_scintillans.jpg.
[68] "UOZU MYSTERY." Welcome to Uozu. Web. 04 Mar. 2011. http://www.city.uozu.toyama.jp/en/htrk/index.html.
[69] "Slender Snipe Eel, Deep Sea, Fishes, Nemichthys Scolopaceus." *Monterey Bay Aquarium, California.* Monterey Bay Aquarium Foundation. Web. 04 Mar. 2011. http://www.montereybayaquarium.org/animals/AnimalDetails.aspx?id=779692.
[70] Yancey, Paul H. "PHY's MIDWATER/Mesopelagic." Deep-Sea Pages: Mesopelagic (Mid-water) Animals. Whitman College, Oct. 2009. Web. 04 Mar. 2011. http://people.whitman.edu/~yancey/midwater.html.

Oarfish[71] [72]



Giant Isopod[73] [74]

[71] NMFS-PIRO. "Ribbon fishes commonly encountered in the Hawaii based pelagic long-line fishery." PowerPoint presentation. Observer Programs, http://ias.pifsc.noaa.gov/lds/obs_training/Ribbonfish.pdf.
[72] Miller, Duke. *Oarfish Washed Ashore at Anna Marie Island*. 2002. Photograph. Australian Museum, Tampa Bay, FL. *Bizarre Giant Oarfish Filmed (w/ Video)*. Physorg.org, 10 Feb. 2010. Web. 4 Mar. 2011. http://www.physorg.com/news185001953.html.
[73] "NOAA Ocean Explorer: Gulf of Mexico: Underside of a Giant Isopod." *NOAA, Ocean Explorer*. NOAA/OER, Oct. 2002. Web. 04 Mar. 2011. http://oceanexplorer.noaa.gov/explorations/02mexico/logs/oct13/media/isopod.html.
[74] "Bathynomus giganteus, 2005." retrieved March 4 2011 from http://en.wikipedia.org/wiki/File:Bathynomus_giganteus.jpg.

CREATE–A–CREATURE

Use the space below to draw your **own** deep sea creature.
Keep in mind what life is like at the bottom of the ocean. After you are done drawing, give your creature a name and prepare a short presentation describing your creature.

Earth Day Network
1616 P Street NW, Suite 340 • Washington, DC 20036
(P) 202-518-0044 • (F) 202-518-8794
www.earthday.org/education • education@earthday.org