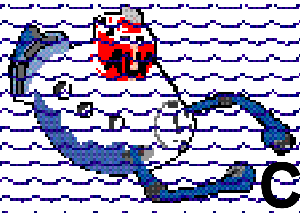


Come On Down!

Focus
Ocean Exploration

Grade Level
Grade 7-8

Focus Question
What technological capabilities are required for the operation of deep sea submersibles?

Learning Objectives
Students will research the development and implementation of a research vessel/vehicle used for deep ocean exploration. (Pre-lab Activity 1)

Students will calculate the density of objects by determining the mass and volume. (Activity 2)

Students will construct a device that exhibits neutral buoyancy. (Activity 3)

Adaptations for Deaf Students
One 45-minute class period will be required for each of the three activities.

Materials (per lab group of 4 students)
- ❒ Graduated cylinder, 100 ml., 1
  Balloons, various sizes, 3
- ❒ Cork, 1
- ❒ Film canisters, 2
- ❒ Bobber, 1
- ❒ Non-lead sinkers, assorted sizes, 3
- ❒ Washers, assorted sizes, 8
- ❒ Straws, 2
- ❒ Clay, 1 block
- ❒ String, 1 meter
- ❒ Wire, 1 meter
- ❒ Fishing line, 1 meter
- ❒ Sand, 100g
- ❒ BB's, 10
- ❒ Water, 25 L
- ❒ Tub, 5 gal.
- ❒ Balance Scale
- ❒ Overflow container, 2 L
- ❒ Aquarium, 5-10 gal.
- ❒ Graph paper, cm, 3 sheets
- ❒ Copies of Student Worksheets #1 and #2
- ❒ Pictures of deep-sea research vessels/vehicles (R/V Flip, Trieste, Jason-Medea, ALVIN). See www.onr.navy.mil/focus/ocean/ and click on "Research Vessels."

Audio/Visual Equipment
Overhead projector

Teaching Time
Two 45-minute sessions

Seating Arrangement
Small groups of four

Key Words
Density
Buoyancy
Positive buoyancy
Negative buoyancy
Neutral buoyancy
Submersible
Volume
Mass

Background Information

The buoyancy of an object is determined by its density (mass/volume). An object that is less dense than its surrounding medium will float, or have positive buoyancy. An object that is denser than its surrounding medium will sink, or have negative buoyancy. An object that floats in the middle is said to have neutral buoyancy.

An object submerged in a fluid has a force pushing up on it that is equal to the weight of the fluid being displaced by the object. This is known as the buoyant force. This idea is known as Archimedes' Principle. Like the object, the force exerted by the fluid depends on its density. For example, we float better in the Great Salt Lake than in a freshwater lake.

The shape of an object will affect the buoyant force against the object, since changing the shape changes the volume of the object. Changing the shape can cause the object to displace a greater or lesser amount of water, thereby changing the buoyancy.

Learning Procedure

In these activities students will investigate the principles of density and buoyancy as they apply to deep ocean research vehicles. The Learning Procedure is addressed in each of the activities.

Activity 1. (Pre-Lab) Exploring Deep Ocean Research Vessels and Vehicles

1. The teacher will introduce the class to deep-sea research vessels/vehicles with pictures of the R/V Flip, the Trieste, the Jason-Medea and the ALVIN. Assign one vessel/vehicle to each student group.
2. Using the Internet site www.onr.navy.mil/focus/ocean/ each student group (4 students, may vary with class size) will be responsible for completing a chart with information about their vessel/vehicle (See Student Worksheet #1).
3. When students have completed their research, have the students record the information about each of the vessels/vehicles using an overhead projector. Students should record information about each of the vessels/vehicles. A class discussion should follow using the following guiding questions:
   a. What is the role of a surface vessel in undersea operations?
   b. What are the advantages/disadvantages of manned vs. unmanned vehicles for deep ocean exploration?
   c. How are these vehicles able to float and sink in the ocean?
   d. What factors determine how deep a vehicle is able to go?

Activity 2. Sinkers and Floaters

1. Distribute a copy of Student Worksheet #2 to each student. Each lab group of 4 students should be directed to choose 4 sample objects from those provided. Identify the object and record information about each object on the data table (for example, red ball, black cube).
2. Use the scale to determine the mass of each object. Record the information on the data table.
3. Use the graduated cylinder and water (an overflow cup may also be needed) to determine the volume of each object by displacement. Record on the data table.
4. Identify each object as a "floater" or "sinker." Record on the data table.

5. As each group finishes their task, their data should be added to a Class Data Table found on the blackboard. Each student should copy the class data onto their data table. (Student Worksheet #2)
6. Students should graph the class data using a line graph, in which the x-axis = volume and the y-axis = mass.
7. When graphs are completed, teacher should have students circle those points identified as "floaters" and draw a box around those points identified as "sinkers."
8. The teacher should then direct the students to draw a line on their graphs where X = Y. Ask students where the "floaters" and the "sinkers" are found. What is the relationship between mass and volume for floating objects and sinking objects?
9. Students should calculate the density of their objects using the following: Density = mass/volume. Infer the relationship between objects with a density > 1. Infer the relationship between objects with a density < 1. What if the mass = volume of the object? (Note: The teacher should introduce the concept of neutral buoyancy.)
10. The teacher should lead a class discussion about the deep-sea vehicles and density. (Since the volume of the vehicle is set, it cannot be changed. The mass can be altered by pumping in water or blowing water out.) They are able to sink to great depths and rise to the surface again.) Make inferences about the mass and volume relationship of these vehicles.

Activity 3. Inquiry: Build Your Own Submersible

Working in groups of four, students will build a device that exhibits mid-water neutral buoyancy, and in doing so, will understand what is required to make deep-sea vehicles hover in the water column.

1. Each group will be given a set of various objects from the Sinkers and Floaters activity; such as corks, lead weights, bobbers, balloons, washers, and string.
2. Each group will choose which objects they would like to use to design a submersible.
3. After designing a submersible, each group will test their device in an aquarium filled with water.
4. Student Self-evaluation
   1. What problem(s) did your lab group encounter with the activities?
   2. Describe your understanding of neutral buoyancy. Why is this an important concept for deep ocean explorers?
   3. If you could build your submersible again, what would you change? Why?

The BRIDGE Connection

www.slackerTV.com/shows/rov.html Students build their own underwater vehicle.

The "Me" Connection

In order to understand the underwater world, submersibles, whether manned or unmanned, must be used. At this point, very little is known about the deep sea. Deep sea exploration is the new frontier.

Connection to Other Subjects

Mathematics
Physical Science

Evaluation

- Group participation
- Graphs
- Density calculations on Student Worksheet #2
- The inquiry lesson can be used as an evaluation tool. The students are trying to achieve neutral buoyancy with their submersible. The students will write a paragraph describing their submersible and explain why it sinks, floats or obtains neutral bouyancy.

National Science Education Standards

Science as Inquiry-Content Standard A:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science-Content Standard B

- Properties and changes of properties in matter

Science and Technology-Content Standard E

- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives-Content Standard F

- Risks and benefits
- Science and technology in society

History and Nature of Science-Content Standard G

- Science as a human endeavor
- Nature of science
- History of science

Pre-Lab Activity
Student Worksheet #1

Research Vessel/Vehicle Information

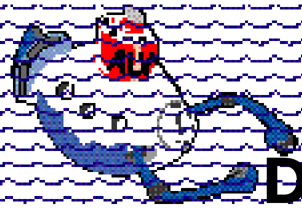
Vessel/Vehicle Name	Submersible Vehicle or Surface Vessel	Greatest Depth Capable of Attaining	Manned/ Unmanned	Unusual Features	Uses

Student Worksheet #2

Floaters and Sinkers Data Table

1. Record your group data.
2. Record class data when directed.

Name of Object	Mass (g)	Volume (ml)	Floater/Sinker	Density D = m/v



Deep Sea Coral Biodiversity

Focus:
Biodiversity of deep sea corals at Georges Bank

Grade Level:
7-8

Focus Question
How might biodiversity vary between tropical reefs and deep sea coral ecosystems?

Learning Objectives
Students will research life forms found on tropical coral reefs to develop and understanding of the biodiversity of the ecosystem.

Students will research life forms found on deep-sea coral reefs to develop an understanding of the biodiversity of the ecosystem.

Students will compare the diversity and adaptations of tropical corals to deep-sea corals

Adaptations for Deaf Students
None required

Materials:
Per group of 4 students:
- ❒ Colored pencils
- ❒ Colored markers
- ❒ Art paper - 2 sheets
- ❒ Books, magazines, and/or posters with pictures of tropical coral reefs

Teaching Time
Two 45-minute sessions

Seating Arrangement
Small groups of 3-4 students, according to the number of students in the class

Key Words:
Biodiversity
Ecosystem
Tropical coral reef
Deep-sea corals

Background Information
Coral reefs are the most luxuriant and complex of all benthic communities. The largest coral reef in the world, the Great Barrier Reef, stretches more than 2,000 km, from New Guinea southward along the east coast of Australia. Corals are colonial animals, and individual coral animals are called polyps. A coral polyp is very similar to a tiny sea anemone, but extracts calcium carbonate from the water and forms a calcareous skeletal cup. Large numbers of these polyps grow together in colonies of delicately branched forms or rounded masses. Most shallow-water coral colonies also have symbiotic algae living in their skeletons. The algae get protection from the coral and, in turn, provide nutrients for the coral polyps. These shallow reef-building corals require warm, clear, shallow, clean water and a firm substrate to which they can attach. Because the water temperature must not go below 18 degrees C and the optimum temperature is 23 degrees C to 25 degrees C, their growth is restricted to tropical waters between 30 N latitude and 30 S latitude and away from cold water currents. Waters at depths greater than 50-100m are too cold for significant

secretion of calcium carbonate. Also, reefs usually are not found where sediments limit water transparency. (from A. C. Duxbury and A .B. Duxbury, 1997, Introduction to the World" Oceans, 5th edition, William C. Brown Publishing Co., Tropical Coral Reefs, p. 460-477).

Until recent legislation banned trawling in deep sea coral beds off the coast of Norway, the existence of deep sea corals was known only to a handful of scientists and a large number of fishermen. Along the American east coast several deep-water corals, such as the octocoral *Primnoa resedaeformis* and gorgonian *Paragorgia arborea*, are common inhabitants of the upper and middle slope faunas in the canyons south of Georges Bank. Deep-water coral colonies can be found in a variety of shapes and forms, from branched trees to conical mounds. Like shallow corals, they require a hard surface to settle on and grow.

Given that the existence of these remarkable species has been known for more than a century, it is striking that almost nothing is known about their biology, population status, the role they play in enhancing local species diversity, and their role as habitat for deep water fishes, including those recently targeted by fishermen. The rarity of encounters with octocorals during recent submersible dives across the shelf of the northeast U.S. suggests that distribution of these species has significantly declined in the past three decades. These slow-growing species may live for centuries, yet be destroyed in seconds by human activities such as trawling and dredging. Trawling with rolling gear has allowed even larger and heavier gear into their rugged canyon homes.

Learning Procedure

This Leg of Deep East 2001: Voyage of Discovery will focus on the Deep Sea Communities in the Georges Bank Canyons. The following two activities (Tropical Coral Reefs – Research and Drawings and Deep Sea Coral Reef - Research and Drawings) will give the students an opportunity to explore the biodiversity of both tropical coral reefs and deep-sea corals.

Activity 1. Tropical Coral Reefs – Research and Drawings

1. After the class is seated (small groups of 4 students), the teacher should ask students to name sea life found on a coral reef. The teacher should write each response on the board. Next, students should be directed to use their research skills to locate photographs and drawings of coral reefs. In addition to marine science texts, encyclopedias, and magazines, the Internet should be used as a valuable tool for this research. The following site should prove useful: www.deepseagallery.com
2. After an appropriate amount of time (teacher discretion), the teacher should redirect the class to their original list of coral reef life forms and ask students for additional life forms to be added. Again, the teacher should write these additions on the board.
3. Next, each group of 4 students should be directed to draw a picture of a coral reef. (Supplies: art paper, crayons, colored pencils, and markers)
4. Share group drawings with the class. Typically students will draw pictures of a tropical coral reef. Use this opportunity to discuss key terms: ecosystem and biodiversity.

Activity 2. Deep Sea Coral Reef - Research and Drawings

1. The teacher should describe for the class the overall goal of the Deep East Voyage of Discovery - Leg One: Deep Sea Coral Communities in the Georges Bank Canyon, which is the characterization of deepwater octocoral communities of the Georges Bank Canyons and on the Bear Seamount. The teacher should point out the location of this site on a World Map. Next, the teacher should ask the class, "Do you think the same life forms you drew on your tropical coral reefs will be found on these deep sea coral reefs?" Use their responses to guide a discussion of the demands of living in a deepwater ecosystem (no light, cold temperatures).
2. The teacher should direct the students to research deep sea coral reefs at the following websites:
   www.publicaffairs.noaa.gov/deepseacoral.html
   www.gulfofmaine.org/times/winter99/deep_corals.html
   www.cnn.com/2000/NATURE/08/10/coral.enn/
3. After an appropriate amount of time (teacher discretion), the teacher should ask the students for names of life forms they have found in their research which live in these deep-sea coral ecosystems. Students may want to share the descriptions of the deep-sea coral reefs dwellers. Next, with the second piece of art paper, the groups should be directed to draw a picture of a deep-sea coral reef using their knowledge of this ecosystem.
4. Share group drawings with the class. The teacher should ask the students to compare the two coral reef ecosystems. How are they alike? How are they different?

The BRIDGE Connection

www.marine-ed.org

Internet websites as noted throughout the activity.

The "Me" Connection

Students should understand the importance of coral reefs as highly productive ecosystems which play a vital role in the productivity of the ocean.

Connection to Other Subjects

Art

Evaluation

Several opportunities to assess student understanding are included with these activities:

- group participation:
- research findings
- drawings (for accuracy or completion)
- compare/contrast a tropical coral reef ecosystem to a deep-sea coral reef ecosystem using a Venn diagram.

Extensions

Learn more about the scientists who will be conducting the research during the Voyage of Discovery – Leg One:

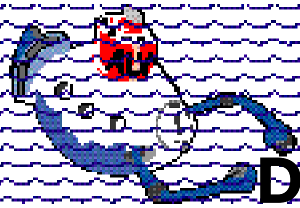
- Les Watling, University of Maine
  www.ume.maine.edu/%7Emarine/watling.htm
- Kevin Eckelbarger, Univ. of Maine
  www.ume.maine.edu/%Emarine/eckelbarger.htm
- Peter Auster, University of Connecticut
  www.advance.uconn.edu/00092509.htm
- Barbara Hecker, Hecker Associates
  www.bu.edu/bump/bios/hecker.html

National Science Education Standards:

Life Science – Content Standard C:

Diversity and adaptations of organisms

NOTES/THOUGHTS/INSPIRATIONS



Down in the Dumps

Focus
Hudson River Canyon

Grade Level
7-8

Focus Question
What are the effects of long-term dumping in the ocean?

Learning Objective
Students will determine the fate and effects of past dumping activities at the DWD-106 mile site in the Hudson River Canyon.

Adaptations for Deaf Students
Teaching time can be increased to 2 class periods. The first class period will be used for explanation and research. This would include the K-W-L chart, the general pollution discussion, and the web searches for background information. The second class period will be used for the debate and wrap-up.

Materials
Resource Sheets (15 Arguments in Support and 15 Arguments Against Dumping)

Teaching Time
One 45-minute session

Seating Arrangement
Divide the class into two groups.

Key Words
Municipal sludge
Biomass
Biodiversity
Pollution
Dumping
Mediator
Debate
Organisms

Background Information
Between 1989 and 1992, a large volume of sewage sludge was deposited off the New Jersey coast. This site is known as DWD-106, or Deepwater Dumpsite 106. The sludge was deposited by a barge at the surface, and the coarser materials settled faster than the smaller particles, which tended to mix with the ocean water.

This dumping affected deep-sea communities in a variety of ways. Increases in certain chemicals and biological changes that were not expected were discovered at the site. The dumping was halted as a result of these findings. Some of these chemicals found their way into the deep-sea food webs, since the sludge-derived organic material was ingested by invertebrates. Scientists are studying some of the invertebrates, specifically the urchin *Echinus affinus*, to see if sludge chemicals have bioaccumulated in these organisms.

Biodiversity at this site is high. The weight distribution of associated fish species seems not to have been affected by the dumping activities when compared with weight distribution of the fish at other sites. The long-term effects of human impact at this dumpsite are now being studied.

Learning Procedure

1. Have the class do a K-W-L chart on municipal sludge.
2. Discuss pollution in general and its effects on ecosystems. Teachers will want to use their own situations so that students can make a connection to their surroundings.
3. Brainstorm good and bad effects of landfills and their surrounding environments. Teachers will then lead a discussion comparing landfilling activities to deep ocean dumping, and how dumping in the oceans could affect those deep-sea ecosystems.
4. Divide the class into two groups; one in support of dumping, one against dumping.
   - The group that will be in favor of dumping could include city officials, landfill management, developers, residents of a large city and its surrounding areas.
   - The group that would be against dumping could include local, state, and federal government representatives, environmental groups, and fishermen.
5. Each group will research the DWD-106 mile site to understand why they would either support or not support dumping (see Resource Sheets). Web sites to use include:
   http://marine.rutgers.edu/nurp/vdover96.html,
   http://marine.rutgers.edu/nurp/grasjf96.html,
   www.csa.com/routenet/cnie/feb98/98feb21.html,
   http://www-ocean.tamu.edu/~wormuth/pollution.html
6. With the teacher or an individual student acting as the moderator, the two groups will debate the pros and cons of dumping at DWD-106.

The BRIDGE Connection

www.vims.edu/bridge/
http://marine.rutgers.edu/nurp/vdover96.html
http://www.csa.com/routenet/cnie/feb98/98feb21.html
http://marine.rutgers.edu/nurp/grasjf96.html
http://www-ocean.tamu.edu/~wormuth/pollution.html

The "Me" Connection

Students will see the end result of the waste products that are produced from our everyday lives. What can be done with this waste? Is dumping in the ocean a solution?

Connection to Other Subjects

Geography, Language Arts, and Health

Evaluation

At the conclusion of the debate, students will write an essay comparing the pros and cons of dumping in the deep-sea. They should be able to give at least two points for either side of the argument.

Extensions

Instead of a debate, the students could have a trial. The class would be divided into roles such as the judge, jury, lawyers, officials, and witnesses. The officials from the large city who authorized the dumping to take place could be put on trial. Witnesses could include those who would be in support of the dumping and those who would be against the dumping. At the end of the trial, the "jury" would decide if the dumping should continue.

National Science Education Standards

Physical Science – Content Standard B

- Properties and changes of properties in matter
- Transfer of energy

Life Science – Content Standard C

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Science and Technology – Content Standard E

- Understandings about science and technology

Science in Personal and Social Perspectives – Content Standard F

- Personal Health
- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

History and Nature of Science – Content Standard G

- Science as a human endeavor
- Nature of science

Student Resource Sheets

In Support of Dumping

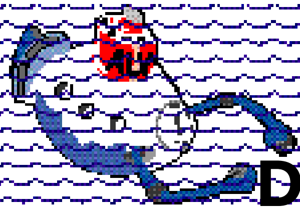
Arguments in support of dumping at DWD-106:

- Large cities have no place to dump waste.
- It keeps the streets clean.
- The onshore environment will be cleaner, including the air quality.
- The weight, or the biomass, of the fish associated with DWD -106 is not affected.
- There is a great diversity of organisms at DWD -106.

Against Dumping

Arguments against dumping at DWD -106

- The chemicals accumulate in the organisms.
- There are biological changes in the organisms.
- The sludge is ingested by the invertebrates and becomes part of the food web.
- The sludge may eventually affect humans through the food web.
- In some places, the sludge is moving back toward land.
- The sludge is also moving downstream, so it affects other locations as well.
- The long-term effects of dumping sewage sludge in the ocean are not yet known.



Design a Deep Sea Invertebrate or Vertebrate

Focus
Blake Ridge - Structure and Function in Living Systems

Grade Level
7-8

Focus Question
What types of adaptations do invertebrates need to live in a methane hydrate habitat?

Learning Objectives
Students will design an invertebrate or vertebrate capable of living in a methane hydrate ecosystem.

Materials:
- ❒ Reference materials such as : encyclopedias , life science textbooks, Internet
- ❒ Colored pencils or markers (one pack per student group)
- ❒ Animal Adaptation Chart (one copy per pair of students)
- ❒ Chart paper
- ❒ Overhead projector, transparency and markers

Teaching Time
Two 45-minute sessions

Seating Arrangement
Students will work in pairs for research.

Key Words
Cold seep communities
Hydrates
Methane
Chemosynthetic
Symbiosis
Bacteria
Polychaete
Mussel
Gastropod
Echinoderm
Benthic
Adaptations

Background Information
Hydrates are a solid structure in which ice forms a cage around a gas molecule. This gas is usually methane. These hydrates can be found deep in the ocean where there is enough gas present and the pressure and temperature are at the right level.

Cold seep communities in the deep, dark ocean are inhabited by chemosynthetic organisms, capable of producing food without sunlight. Bacteria that live either alone or symbiotically within some deep-sea animals, such as tube-worms and mussels, manufacture food used by these organisms to live, grow, and reproduce. Each of these organisms is uniquely adapted to the specific environment in which they live.

Organisms adapt to their environment in the following ways:

1. They need to be a certain shape, or form, depending on where they live,
2. They may or may not need to move around. Some organisms are sessile, or immobile. They only move in their larval stage. Once they reach their adult phase they stay in one place. They need some sort of adaptation to stay in that place. Other organisms move about. They need

an adaptation to help them move.

3. All organisms need food. Some organisms filter food through gills, while others take in food through a mouth. They also need to get rid of wastes.
4. All organisms need protection from predators and environmental stress. This protection may be camouflage, special body parts, a heavy, protective outer layer, and/or some form of locomotion, or a metabolic process to handle stress.
5. All organisms need to reproduce. Reproduction may be sexual or asexual.

Learning Procedure:

1. Make one copy of the Animal Adaptation Chart for each pair of students.
2. Given polychaete, mussel, gastropod, echinoderm, or a fish, each student pair will choose one animal, research using available references (Internet, encyclopedias, and/or textbooks), and complete the Animal Adaptation Chart for adaptations.
3. Compile a class chart of adaptations of all groups.
4. As a class, brainstorm adaptations required for survival in a deep-sea oil and gas seep ecosystem. Students need to remember the parameters of the ecosystem, such as cold, no light, and the presence of chemosynthetic bacteria. Visit www.hydrate.org/about/biology.cfm for more background information on organisms that live in cold seep communities.
5. Each student will design and draw an invertebrate or vertebrate capable of living in this ecosystem. Each invertebrate/vertebrate must exhibit adaptations in body form, locomotion, feeding, protection, and reproduction.

The BRIDGE Connection:

www.hydrate.org

The "Me" Connection

Students will see the importance of adaptations in the survival of deep-sea organisms and relate these specializations to the demand of the deep-sea environment.

Connection to Other Subjects

Art

Evaluation

Adaptation charts from each student pair may be evaluated for completeness and student drawings may be evaluated for understanding adaptations.

Extensions

- Have students write a story about "A Day in the Life of…" for the animal they chose to design. They should explain the unique adaptations of the animal within the story.
- The student pairs could get together with other student pairs to form a food web that incorporates several of the animals they designed.
- Students should research the animals that actually live in the cold oil and gas seep communities.

National Science Education Standards:

Life Science Content Standard C:

- Structure and Function in Living Systems
- Reproduction and Heredity
- Regulation and Behavior
- Populations and Ecosystems
- Diversity and Adaptations of Organisms

Student Sheet

Animal Adaptation Chart

Directions: Use provided references to complete the following chart for your invertebrate / vertebrate.

Animal:

Describe its body form.

Describe how it moves.

Describe how it feeds.

Describe how it protects itself.

Describe how it reproduces.

Notes/Thoughts/Inspirations