“BOTTOMS-UP”
Curriculum

Marine Science Activity Book

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“BOTTOMS-UP” Research Project Summary

By Jeff Graham

Benthic Observatory and Technology Testbed On the Mid Shelf – Understanding Processes (BOTTOMS-UP) is a collaborative research project under the direction of Dr. William Savidge at Skidaway Institute of Oceanography (SkIO). It is a long term study of the interaction between the ocean floor and the water column interface. The key is to follow the cycling of carbon between the biotic and abiotic factors that help to cycle carbon from the permeable ocean floor to the water above it and back and to determine how the geological makeup of the seabed impacts that cycle.

BOTTOMS – UP is using a three-pronged approach to understand the benthic processes of the South Atlantic Bight (SAB):
1. Continuous surface sampling of wind speed and direction.
2. Continuous sampling of water temperature, salinity, and turbidity.
3. Occasional sampling of biotic activity from the “R/V Savannah.”

As we know, the ocean is a tremendous carbon dioxide sink at the atmosphere and ocean surface but the cycling between the ocean floor and the water column interface is less understood. BOTTOMS –UP is a research project that will put in place long term sensing equipment on the ocean floor that will constantly gather, salinity, current direction and speed, conductivity, temperature, depth, chlorophyll levels, and other data at the mid-shelf of the (SAB). The SAB is the area formed by the indentation along the southeastern coast between Florida and North Carolina. The research site for BOTTOMS-UP is located approximately 50 km offshore near R2, a naval navigational tower that has an existing, sustained power supply, located in 27 m of water. Long-term, sustained data gathering instruments are located on and below the tower and periodic expeditions of the “R/V Savannah” research ship will allow scientists to deploy benthic instrumentation that will gather biogeological data from the ocean floor.

Much of the data recovered will be in the form of quantifying sediment size to help determine the impact that the permeability of the ocean floor has on carbon cycling. To do this, periodic research missions will collect core samples of the seabed to determine sediment size, biologic activity, and photo respiration rate. Surface, mid-depth, and bottom plankton tows will also be made to quantify biological activity throughout the seasons. This data will help scientists to understand this very dynamic but little known ecosystem.

In an effort to include an educational component to this research project, Karen Moyd and myself were given the opportunity to work closely with Dr. Bill Savidge and his team of scientists to develop lessons that relate to the work being done by “BOTTOMS-UP.” Five teachers (from across Georgia and South Carolina gathered to create and test the activities in this curriculum. Our desire is for you to be able to complete these activities with your students with a minimum of teacher preparation and a maximum of student engagement.
Dr. William Savidge

As the lead scientist, Dr. Savidge, began his desire to understand the natural resources of the earth at the mere age of five. His passion progressed as an undergraduate in summer classes at Duke Marine Lab. He believes that the most impressive oceanic discovery includes his appreciation of the magnitude of the anthropogenic influence on the function of the ocean. He predicts that we will continue to develop our understanding of how climate change and overexploitation of food webs will manipulate how the oceans work. We will have a better sense of what those changes will look like and how they will affect human populations and the global ecosystem. It is his desire to see students using and judging evidence, inferring trends from quantitative data, and generally developing the mental habits that scientists must use continuously to understand the world.
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How Far does the Carbon Flow?

By: Karen Moyd

In collaboration with the BOTTOMS-Up research project.

Grade Level: 9-12

Georgia Performance Standards: SEV1

National Standards: Content Standard A and D

Type of activity: Web Quest

Focus Questions: How is carbon transferred through the five basic cycles of our earth?

Objectives:
1. Identify the elements/processes in each of the following cycles: carbon, nitrogen, phosphorus, sulfur, and water/hydrological.
2. Contrast and compare the elements/processes of each cycle to one another and identify the common parts.
3. Analyze how the carbon of organisms interact with the biosphere as part of the flow in the biogeochemical cycles (carbon, nitrogen, phosphorus, sulfur, and water cycles).
4. Recognize particular problems that humans are experiencing due to human interference with the cycles.

Materials:
- Poster paper
- Marker
- Construction paper
- Computer internet

Key Words:
The Vocabulary/Chemical formulas needed for web Quest:

(HCO₃)  Fertilizers
(NH₄)  Fish Kills
(NO₂)  Fossil Fuels
(NO₃)  Global climate
Acid  Global warming
Animals
ATP  H₂O
Bacteria  H₂S
H₂SO₄
Biogeochemical Cycles
Biogeochemical Cycles
Biosphere
Biosphere
C
C
CaCO₃
CaCO₃
CH₃SCH₃
CH₃SCH₃
Classification
Classification
CO₂
CO₂
Communities
Communities
Dinoflagellates
Dinoflagellates
DNA
DNA
Dynamic Equilibrium
Dynamic Equilibrium
Economy
Economy
Ecosystems
Ecosystems
Environmental Concerns
Environmental Concerns
Eutrophication
Eutrophication
Evaporation
Evaporation
Evolutionary Changes
Evolutionary Changes
Feedback Mechanisms
Feedback Mechanisms
HNO₃
Invertebrate
N₂
NO₂
Ozone
Photosynthesis
Phytoplankton
Plants
Pollution
Populations
Precipitation
Protein
Respiration
Run-off
Shellfish
SO₂
Toxic blooms
Transpiration
Volcanoes

Background Information/Web Resources:
• Carbon Cycle: http://www.cotf.edu/ete/modules/carbon/efcarbon.html
• Nitrogen Cycle: http://www.eoearth.org/article/Marine_nitrogen_cycle and
  http://www.eoearth.org/article/Marine_nitrogen_cycle
• Phosphorus Cycle:
  http://www.lcusd.net/lchs/mewoldsen/4/4_Philosophus_Cycle.ppt#13
• Sulfur Cycle:
  http://www.soils.wisc.edu/soils/courses/451/20b.%20Global%20S%20cycle.ppt#10
• Toxic Tides: http://findarticles.com/p/articles/mi_m1200/is_/ai_19897506

Procedure/Observations:
1. Each student of a team of five using internet resources will research one of the five
cycles: carbon, nitrogen, phosphorous, sulfur, and water. As they gather their
information they will produce a display board which explains the cycle assigned. As
a ticket out of the door on this day, students should use the team’s productions to
complete the formative assessment. (See Appendix 1.)

2. Each team will review the five completed visual displays contrasting and comparing
the elements and processes found within each cycle. Each person will be assigned a
designated colored marker for their cycle: carbon = blue, nitrogen = green,
phosphorous = purple, sulfur = yellow, and water/hydrological = red. Students will approach each of the teams posters and circle the common items in the color assigned.

3. Individually students will record the findings of the group on the semantic feature analysis grid provided. (See Appendix 2.)

**Conclusion:**
In a 3 paragraph essay, students will evaluate their grid following a class discussion on:
- The common factors found in all five cycles
- How carbon (animal/plant life) interacts in the ocean/land to aide in the transfer of elements through cycling
- How human interference disrupts the nature flow of carbon throughout our earth
Appendix 1

Name________________________ Date________________________

Formative Assessment for Biogeochemical Cycles Activity

**Directions:** For each of the following cycles, provide two facts using complete sentences that you and your partners have discovered through your discussion. Please turn this in before you exit today.

1) Hydrological Cycle:
   a.________________________________________________________
   b.________________________________________________________

2) Carbon Cycle:
   a.________________________________________________________
   b.________________________________________________________

3) Nitrogen Cycle:
   a.________________________________________________________
   b.________________________________________________________

4) Phosphorus Cycle:
   a.________________________________________________________
   b.________________________________________________________

5) Sulfur Cycle:
   a._______________________________________________________
   b._______________________________________________________
# Appendix 2

## Semantic Feature Analysis Grid for Biogeochemical Cycles

<table>
<thead>
<tr>
<th>Features</th>
<th>Hydrological Cycle</th>
<th>Carbon Cycle</th>
<th>Nitrogen Cycle</th>
<th>Phosphorous Cycle</th>
<th>Sulfur Cycle</th>
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<tr>
<td><strong>Chemicals/Terms</strong></td>
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<td>(HCO$_3$)</td>
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<td>Acid</td>
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<td>Animals</td>
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<td>ATP</td>
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<td>Bacteria</td>
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<td>CaCO$_3$</td>
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<td>CH$_3$SCH$_3$</td>
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<td>CO$_2$</td>
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<td>DNA</td>
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<td>Eutrophication</td>
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<td>Evaporation</td>
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<td>Fertilizer</td>
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<td>Fossil Fuels</td>
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<td>Global climate</td>
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<td>H$_2$O</td>
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<td>H$_2$SO$_4$</td>
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<td>HNO$_3$</td>
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<td>O$_2$</td>
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<td>Photosynthesis</td>
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<td>Phytoplankton</td>
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<td>Plants</td>
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<td>Precipitation</td>
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<td>Protein</td>
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<td>Respiration</td>
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<td>Run-off</td>
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<td>SO$_2$</td>
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<td>Toxic Blooms</td>
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<td>Transpiration</td>
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<tr>
<td>Volcanoes</td>
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Benthic Retrieval Using a Remotely Operated Vehicle

Original Activity By Karen Moyd adapted by Dan Genrich
In collaboration with the BOTTOMS UP Research Project

Grade Level: 9-12

Georgia Performance Standards: SCSh3 a, b, c, d, e, f; SCSh4 a, c

National Standards: Content Standard A and E

Type of activity: Lab

Focus Questions: How are the ocean depths explored?

Objectives: Students will:
1. Design and create a remotely operated vehicle (ROV) that will be able to accomplish specified tasks.

Materials:
- Battery driven electric motors (available at hobby shops)
- Plastic propellers (1 per motor)
- Electrical tape
- Styrofoam ‘peanuts’ (non-biodegradable)
- 2 strand wire
- Alligator clips
- 9 volt batteries
- Magnetic hooks
- 6-10” PVC pieces
- plastic coat hangers
- Pipe cleaners
- scissors
- Large trash can
- Metal washers
- Hot glue
- Swimming pool (Optional)

Key words:
Hydraulics
Magnetometer
Manipulator
Remotely operated underwater vehicles (ROV)
Sonar
Neutral buoyancy
Background Information:

Remotely operated underwater vehicles (ROV) is the common accepted name for tethered underwater robots in the offshore industry. ROVs are unoccupied, highly maneuverable and operated by a person aboard a vessel. They are linked to the ship by a tether, a group of cables that carry electrical power, video and data signals back and forth between the operator and the vehicle. High power applications will often use hydraulics in addition to electrical cabling. Most ROVs are equipped with at least a video camera and lights. Additional equipment is commonly added to expand the vehicle’s capabilities. These may include sonar, magnetometer, a still camera, a manipulator or cutting arm, water samplers, and instruments that measure water clarity, light penetration and temperature. Oceanographers use ROV’s to explore the ocean depths. This technology allows scientists to safely, and with relatively little expense, explore ocean ecosystems otherwise not accessible to humans. An appropriate example is the discovery of the “Titanic” by Dr. Robert Ballard. Neutral buoyancy is achieved when the ROV floats just beneath the surface without sinking.

Procedure:

In this activity students will use an assortment of materials to build ROV’s that will be able to retrieve washers from the bottom of the large trash can. If a swimming pool is available, that works very well and will allow more than one group to use their ROV at a time.

1. Using the motor, electrical tape, propeller, plastic washer and hot glue, attach the propeller to the motor.
   a) Start by wrapping the shaft with electrical tape until the plastic washer fits tightly over it.
   b) Apply hot glue to the washer and attach the propeller.

2. Carefully strip the insulation from the wires with a knife and attach one wire to each of the terminals on the motor.
   a) Attach an alligator clip to the other end of each wire.
   b) Test the motor and connections by attaching the clips to the battery.
   c) Reverse the wires on the battery to run the motor in the other direction.

3. Attach the motor to the coat hanger or PVC and begin designing your ROV!

4. Be sure to attach the magnetic hook in order to retrieve the washers.
   a) Add Styrofoam peanuts to increase buoyancy. Other materials may be added in order to achieve neutral buoyancy.
**Observations:** Students should answer the following questions.

1. How did your ROV perform?
2. What difficulties did you encounter?
3. What was the most successful design?

**Conclusions:**
Combine your experience in this activity with internet research to write a one page paper on how the ROVs can be used to explore the ocean depths. Include a variety of practical applications for this technology. Be sure to include specific design ideas and difficulties. Discuss other ways your ROV could be used.

**Extensions:** This activity works very well as a competition! Have students challenge their classmates to see who can collect the most washers in a given period of time.
From the Bottom to the Top
Original Activity by Karen Moyd adapted by: Dan Genrich
In collaboration with the BOTTOMS UP Research Project

Grade Level: 9-12

Georgia Performance Standards: SCSh2 a, b, c; SB3 a, b, c, d

National Standards: Content Standard A and C

Type of activity: Lab

Focus Questions: How do marine scientists collect samples of the organisms living on the ocean floor?

Objectives: The students will.
1. Design and build their own sampling sled like the ones research scientists use for benthic sediment/biological retrieval.
2. Investigate how marine scientists sample the organisms on the ocean floor.
3. Identify the problems facing the scientists in designing and deploying a successful sampling mission.

Materials:
For ocean, bottom and miscellaneous organisms
- Shallow water proof bin (I.E. under the bed storage bin)
- Sand
- Corkscrew (tricolor), bowtie and shell pastas
- Rice
- Raw black eyed peas
- Elbow macaroni
- Small plastic beads
- Blue food coloring or dark colored dye

For ‘Sled’ (suggested list)
- Plastic putty knives
- Pipe cleaners
- PVC pipe
- Assorted small plastic cups
- Plastic bottles
- Yarn or string
- Rubber bands
- Zinc washers (for weight)
- Electrical tape
- Other assorted materials.
Key Words
Benthic  Seine net
Cast net  Towing Dredge or Sled
Demersal  Trawling net
Plankton net

Background Information:

Obtaining samples of the organisms in a marine habitat is crucial to an understanding of that habitat and the conditions that govern life there. There is no shortage of means to gather these samples in shallow water. Trawling nets, seine nets, plankton nets and even cast nets can be used for specimen collection purposes. Deeper water, anything more than 15 meters, makes most of these tools less than ideal. A towing dredge or sled allows the scientist to sample the benthic and demersal organisms in a given marine habitat. These are pulled behind a boat or dragged across the bottom, capturing any organisms along its path. These sampling devices, like many pieces of marine science equipment, are often designed and built by the scientists themselves to meet the demands of a specific mission. In this activity, students will design, build and use their own towing dredges to sample the ‘organisms’ in the ‘marine habitat’ that will be created by their classmates. The basic design would need to include something to act as a ‘shovel’ to scoop along the bottom and some sort of ‘bin’ to hold the collected materials as the dredge moves along and while it is returning to the surface. Other considerations would include sufficient weight to break the surface of the sand and the dredge being at the proper angle to scoop a sample from the bottom.

Procedure:

1. Divide the class into an even number of groups of 3-4 students.
2. Designate ½ of these groups as ‘A’ and the other groups as ‘B’.
3. Have groups ‘A’ create a marine floor ‘habitat’ in the bin. Have them cover the bottom with sand and populate the ocean floor with the pasta, rice, beads and etc. representing various organisms. Students will create a key for later identification of the organisms that they distribute at the bottom, and throughout the water column. Students will provide a rationale for their distribution. Example; green pasta represents marine algae and would be found in areas exposed to sunlight. Small beads might represent fish as they often float at various levels in the water column in much the same way that fish do.
4. The ‘A’ groups then add water to the bin slowly and gently to prevent disturbing the ‘marine floor’. Add food coloring until the water is nearly opaque.
5. Instruct the ‘B’ students to design and build a tow sled to sample the ocean bottom.
6. The group ‘B’ design team will use their sled to gather ‘biological’ samples from the ‘ocean floor’ by dragging it across the simulated ocean bottom.
7. A sampling mission is not complete until the sled is out of the water. Students doing the sampling will then use the key to identify and sort the organisms.
Observations:

1. Did your sled design work as intended?

2. What difficulties did you encounter?

3. Use the student made key to **taxonomically** identify the organisms in your sample and list what you know about the characteristics of those organisms, describe the conditions that exist on the ocean floor of the area that you sampled.

4. How many of each organism did you collect?

Conclusions:

In a 2-3 paragraph essay explain how marine scientists collect samples of living organisms from the ocean floor. Describe the difficulties you experienced with your design and explain how real marine scientists face the same and other challenges as they design full scale equipment for actual oceanic research.
Interview an Oceanographer
By Karen Moyd and adapted by Scott Thompson
In conjunction with BOTTOMS UP Research Project

Grade Level: 9-12

Georgia Performance Standards:  SCSh1 a, b, c; SCSh7 a, b, c, d; SCSh8 a, b, c, d, e

National Standards:  Content Standard A

Type of Activity:  Computer-based

Focus Questions:
1.  What can you learn about science and the study of the oceans from a working oceanographer?
2.  How does this affect your interest in oceans and oceanography?

Objectives:  The students will investigate:
1.  The factors have drawn people to scientific study.
2.  The rewards to be found in the study of oceans.
3.  The drawbacks or difficulties in pursuing a scientific career.
4.  The difficulties encountered by a working oceanographer.
5.  The importance of devoting time, energy, and passion in the study of the ocean.
6.  Careers in oceanography.

Materials:
Internet and e-mail access

Key Words:
skills  work day
interest  salary
educational background  research science

Sample Interviews:
Below are interviews conducted with oceanographers at the Skidaway Institute of Oceanography near Savannah, Georgia. The template below provides you with questions that you might ask an oceanographer. Use this as a guide. You may create your own questions depending on your interest; however, these must be approved by your teacher before contacting the scientists. Before you contact your scientist, conduct research on careers in oceanography so that you can form and ask good questions. Use the websites in “Web Resources” below to guide your research.
1. **Name:** Dana K. Savidge
2. **Discipline:** Physical Oceanography
3. **Educational Background/ Certifications**
   - **Degree:** BA physics (math minor), Hanover College, Hanover In. MS geophysical sciences, Ga. Tech, Atlanta Ga. PhD marine sciences, UNC, Chapel Hill, NC
4. **Main Research topic/field:** Coastal physical oceanography
5. **Present Occupational Position:** Assistant Professor
6. **Years of experience:** 5 years in present position, 11 years since PhD, 21 years in oceanography research
7. **When did you decide to make research science your vocation?** During masters degree thesis work
8. **What shaped your decision to enter the oceanographic field?** Interesting work, good people
9. **Summarize your impact in marine/oceanic research.** I have highlighted important cross-shelf transport pathways in the coastal ocean, and furthered the use of important new observational techniques.
10. **What have you experienced/seen over the past 20 years to be the most exciting/important in oceanic studies/discoveries?** Many new discoveries have been exciting – the most important features of the evolving field of oceanography are 1) the development of new observational methods (autonomous vehicles, HF-radar, exciting new bio and chem. sensors), and 2) expanding computing capabilities with decreasing physical size.
11. **What do you predict for the near future (10 years) in for oceanic revelations?** I am a scientist, not a fortune teller. I expect our continuously improving observational and modeling capabilities to reveal increasing levels of complexity and many surprises.
12. **What is your personal favorite portion of marine inquiry?** I enjoy experiment planning and data analysis more than any other component of my work.
13. **How would you like to see your research content/methods be utilized in the current public educational system?** Depends on the grade level. For K-6, using data to describe variability in the world would be good: seasonal heating and cooling, spatial changes in salinity due to variability in sources of freshwater. For 7-12, beginning to understand what forces and force variability control the spatial and temporal variability would be good.
14. **email:** dana.savidge@skio.usg.edu
1. **Name:** Charles Robertson  Atlanta GA  
2. **Discipline:** Microbiology Access to Oceanography  
3. **Educational Background/Certifications/Degree:** University of Washington, Biology BS, Masters Degree in Microbiology  
4. **Main Research topic/field:** Biological Oceanography: Optical Oceanography subtopic, Color in the ocean, measurements and the consequences of turbidity and how it affects the phytoplankton and benthic community  
5. **Present Occupational Position:** Deep sea exploration, Benthic ecology, has been in Alvin 2500 feet in 1999. Nutrient chemistry/waste of ammonification.  
6. **Years of experience:** since 1982  
7. **When did you decide to make research science your vocation?** At 7 years old he wanted to be a garbage man so he could ride on backs of trucks. Then his Uncle Bill, a geologist, gave him a technical report when the Alvin was impaled by a sword fish. This interested Charles at 7 years old as he and his uncle were photographed for a picture in the newspaper while eating the fish that speared it. At 12 he wrote asking for the blueprints and they sent them to him. They then invited him to ride on the Alvin. Thanks to Uncle Bill, Charles now has the prized shrunken Styrofoam cup from his journey on the Alvin. Quantitative analysis has always excited him.  
8. **What shaped your decision to enter the oceanographic field?** With his high writing ability, Charles is a natural in competing for NSF funds. Due to his family background he has always been surrounded by inquisitive individuals.  
9. **Summarize your impact in marine/oceanic research.** He works fundamentally in research that is applicable to the world in general. He also helps with the SABSOON projects and UGA. This is pure research which could help Japan as they study continental shelf/benthic primary production. Previously we have thought that light did not penetrate the ocean floor, but we now have found differently.  
10. **What have you experienced/seen over the past 20 years to be the most exciting/important in oceanic studies/discoveries?** Hydrothermal vents 1977, chemosynthesis, discovery 30 years ago that copepods acquire food by actually creating their own current to attract a meal and in turn can differentiate between nutrient quality for selection.  
11. **What do you predict for the near future (10 years) in for oceanic revelations?** Understanding Biogeochemical cycles completely, Global warming research expanded to placing Wallace Tracers in the Oceanic Conveyor Belt, the ability to control the weather, fine tuning fisheries, recognizing that oil spills are a fate of life.  
12. **What is your personal favorite portion of marine inquiry?** A particular species of phytoplankton which appears as egg drop soup. At a depth of 27 meters, Jim Nelson isolated *Phaeocystis globosa* (Robertsonii). DNA testing confirmed it. It only occurs once very 15 years. Uniquely, they wait on favorable conditions.  
13. **How would you like to see your research content/methods be utilized in the current public educational system?** Any real time data usage would greatly enhance the excitement of the field.  
14. **email:** Charles.robertson@skio.usg.edu
Student Procedure:
1. Use the suggested other web resources contact to find information about an oceanographer.
2. Compose an introduction letter and contact the scientist by e-mail.
3. Introduce yourself by name, school, and the course you are taking.
4. Describe this assignment and explain your purpose for contacting them.
5. Ask politely if they would take time to respond to your questions about their work as an oceanographer.
6. Send them the questionnaire (Appendix I) and ask if they would fill it out.

Conclusions: Write a narrative biography of the scientist you have chosen to investigate. Use information you have obtained about this individual from websites along with the responses to the interview questions. Write this using your own words, complete sentences, explanations, examples, and appropriate vocabulary to address the following questions:

1. Who is this person? Describe the following:
   a. Where does he or she work?
   b. What are his or her areas of interest or research?
   c. What skills are necessary to perform the job?
2. What factors led this individual to pursue a career in oceanography?
3. What are the benefits and drawbacks of the job?
4. What questions are they investigating?
5. Finally, include a reflection of your own feelings by addressing the following questions:
   a. How did this assignment change your perceptions of careers in oceanography?
   b. How did this assignment change your perceptions of the importance of the world’s oceans?

Web Resources:
Women Oceanographers.org - http://www.womenoceanographers.org/
Ask a Scientist - http://whale.wheelock.edu/whalenet-stuff/ASK_SCI.html
Ask a Marine Scientist - http://oceanlink.island.net/biodiversity/ask/ask.html
ScienceStuff.NETwork - http://www.sciencestuff.net/ask/
Appendix I

Sample Questions for an Interview with a Research Scientist

1. Name of scientist:

2. What is your field in oceanography?

3. What is your educational background?

4. What is your main research topic?

5. What is your present position?

6. How long have you worked in your field?

7. When and what made you decide to make research science your vocation?

8. What do you feel are your most important contributions to oceanographic research?

9. What do you think are the most exciting/important discoveries in oceanography since you began your studies?

10. What do you think are the most pressing problems related to the oceans?

11. What do you like best about working as an oceanographer?

12. What is the toughest part of being an oceanographer?

13. Do you think it is important that educators use your research in schools? Explain.

14. What would you tell a young person to convince them that oceanography is a worthwhile career?

15. Do you have any questions to ask me?
Counting Plankton Lab, a Quantitative Study
“Carbon in the Column”
By: Ann M. Middleton
In collaboration with the BOTTOMS-UP Research Project

Grade Level: 9-12

Georgia Performance Standards: SB 3a; SB 4a; SO 2d; SEV 1b, 1d, 2d, 3a, 3d

National Standards: Content Standard A, C, D

Type of activity: Lab

Focus Question: How can we count the number of plankton in the water column?

Objectives: The student will be able to:
1. Count a sample of plankton on a microscope slide.
2. Identify available plankton on a prepared slide by utilizing an available reference key.
3. Extrapolate a population study of plankton from a limited count of specific plankton utilizing a grid counting mechanism.

Materials:
Preserved specimen of Plankton sample
Droppers
Microscope slides
Cover slips with grid markings
Compound microscope
Reference key for Phytoplankton (see web resources)
Reference key for Zooplankton (see web resources)

Key Words:
Phytoplankton
Diatom
Zooplankton
Flagella
Cilia
Autotrophic
Heterotrophic
Photosynthesis
carbon fixation
chlorophyll
detritus
wet mount slide
plankton tow
fresh plankton
preserved plankton
detritus
Background Information: Plankton is a term used to describe the small microscopic plants and animals that float in the water. Plankton lives as deep as the light can penetrate. **Phytoplankton** is autotrophic, utilizing chlorophyll to produce food and lives near the surface of the water. **Phytoplankton** has adaptive features that help them stay near the surface, such as oil droplets, and spines for increased surface area, along with silicon like shells. **Zooplankton** feed on **phytoplankton** and will consequently travel to the surface. **Zooplankton** may have flagella and cilia to help with mobility. **Carbon fixation** happens when carbon is fixed into glucose during the **photosynthetic** process by the plankton and used in the formation of protective shells of many of these microscopic organisms. Deceased **plankton** forms part of the **detritus** which settles to the ocean floor. A **plankton tow** is a net used to collect plankton in the water column. Once collected, **plankton** is then washed and filtered into collection jars where it may be preserved for future study. Living **plankton** may also be microscopically observed by making a **wet mount slide**.

Procedure:
1. Make a wet mount of a sample of **preserved plankton**, use a grid cover slip (the grid cover slip is made by scratching a plastic cover slip into 30 even squares using probe and a straight edge) and view under low power.
2. Using a reference key for **phytoplankton** and **zooplankton**, list and diagram the various organisms that you find in your sample.
3. Using low or medium power, methodically move your slide from left to right on the microscope stage. Count each type of **plankton** in each grid as you go. Document your findings in the table.
4. Make a second wet mount sample of preserved plankton, identify, view and count your plankton in this slide.

Observations:
1. On a plain sheet of paper, sketch and identify the plankton you observe on two separate slides.
2. Create a table similar to the one below (add or delete lines as needed):

<table>
<thead>
<tr>
<th>Identity of Plankton</th>
<th>Number on slide 1</th>
<th>Number on slide 2</th>
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</thead>
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</tbody>
</table>
Conclusions:
In your own words and in paragraph form describe how scientists count the abundance of plankton in the water column.

Web resources:
www.marine.usf.edu/pjocean/packets/f97plank_id.pdf
http://cfb.unh.edu/cfbkey/html/begin.html
For the Teacher
How to Collect Plankton samples

Procedure for collecting Plankton samples:

The teacher will need a plankton net (if the teacher does not have plankton net, a net can be made with nylon stocking attached to a round hoop) with an attached jar (a mason jar is good). Go to the aquatic area, either fresh water or sea water. From the shore, pier or dock, drop the plankton net in the water, let the current carry the collection jar away from the mouth of the net. If there is no current, walk the net back and forth. If there is a current, leave the net in the water for 10 minutes or so. Pull up the net, squeezing out excess water. Do not dump the collection jar. This contains the plankton organisms. Unscrew jar from plankton net and transport it to your lab. If you are not going to use the sample within 24 hours, then you will need to preserve the sample by adding 250 ml of isopropyl alcohol.

To make the wet mount slide, extract the specimens from the jar using a pipette. Place a drop on the slide and place the cover slip over it and observe the slide using a compound microscope. You can also observe plankton by placing several drops into a petri dish (must use a dissecting microscope if you use the petri dish)

If you are using a live sample and want to slow the plankton down, add a drop of “Proto-Slow” onto the slide.
Core Sampling in an Aquatic Habitat
By Scott Thompson
In collaboration with the BOTTOMS UP Research Project

Grade Level: 9 – 12

Georgia Performance Standards: SES 1e, SC 7a, S6E5 f and h, SO 1d

National Standards: Content Standard E

Type of Activity: Lab/Data Analysis

Focus questions:
1. What is the physical nature of sediments found in aquatic ecosystems such as ponds, estuaries, and the ocean floor?
2. How many living things are found in these sediments?
3. How do the abiotic conditions present in these sediments affect the biotic factors found there?

Objectives: The student will:
1. Describe the physical structure of sediment cores taken from aquatic habitats.
2. Compute and compare the ratio of autotrophs to heterotrophs in a benthic sample.
3. Compare observed ratios to those computed by classmates to check reliability in observations and ratios.

Materials:
- Soil sampler or 5 cm x 30 cm clear PVC screw-capped at one end
- White enamel tray or Styrofoam plate for each student group
- Stereo microscope
- Petri dishes

Key Words:
Sedimentation compaction cementation
Density Detritus
Biogeochemical cycles radiometric dating

Background Information:

Solid particles of sand, soil, and dust are constantly carried by wind, water, and ice to ponds, lakes, and the ocean. Once deposited, this is known as sedimentation. Layers of sediment accumulate over time to provide clues to the history, interactions, and overall health of both local and global ecosystems. These sediments are collected from rainwater runoff, streams, rivers, the air, and even the living things that live in the water. Sediments may also form through the physical and chemical processes that occur in the formation of rock features such as limestone deposits that make up many parts of North America. The physical structure of these sediment layers and the organisms they contain can tell us
much about what has come before in terms of weather and climate. They can also tell us about the more recent influences of humans and pollution.

Sediment cores are collected using a coring tool. These tools range from simple hand-held tools that might be plunged into the bed of a pond or estuary to 1200 kg core samples launched from ships to study the sea floor. The idea is the same in all - Force a tube into the sediment and collect the dirt and living things that live in it.

For example, scientists at the Skidaway Institute of Oceanography near Savannah are sampling sediment off the Georgia coast to determine what role the deep ocean plays in the development of continental shelf ecosystems. What goes on at the continental shelf gives clues to the overall state of our global ocean as well as indications of human influences.

By sampling the sediment layers in a body of water near you, you can contribute to the knowledge of important living and nonliving factors that make up that ecosystem. You may also be able to describe environmental impacts and the effects they have on these ecosystems.

Procedure:

**Collect core sample(s):** Depending on location and availability, collect core samples from nearby aquatic habitats. These may be marine estuaries or local fresh water ponds.

1. Plunge the core sampler into sediments in a pond or estuary. If you use your home made core sampler, screw the cap on the top to create a vacuum.

    **Caution: you will get wet and muddy in this endeavor.**

2. Gently remove the sampler so that sediments remain intact. This may take some practice.
3. Place the sampler with sediment onto a tray and secure the bottom with a sandwich bag and rubber band. Bring back to the classroom.

Observations:

**Process the sample:**
- Remove the screw-cap from the sampling device.
- Gently slice off sections of the sample into Petri dishes or Styrofoam plates and give one sample to each student group.
- Students can observe these using the stereomicroscopes. As they observe the samples, have them answer the following questions:

    1. What is living and what is not? Sketch both living and nonliving things in your sample.
2. Estimate the approximate size of sediment grains. Do you consider these particles to be small, medium, or large particles?
3. Classify the living things as autotrophs or heterotrophs.
4. Count the autotrophs and heterotrophs. Compute a ratio to share with your classmates.
5. Describe the physical size of the particles in the core sample. Are they all the same size or do the particles differ in size?
6. If your ratio of autotrophs to heterotrophs is high (a large number of autotrophs), what factors contribute to their survival?
7. If the ratio of autotrophs to heterotrophs is low, what do you think forms the basis for the trophic interactions in this habitat?

**Conclusions:**

Research the Web Resources below and write at least a 2 paragraphs summary explaining the physical nature of sediments found in aquatic ecosystems and the amount of living things found there. Explain how abiotic conditions present affect the biotics factors found in those sediments.

**Web Resources:**

- http://www.scionline.org/index.php/Land_Use,_Erosion,_and_Sedimentation_in_Aquatic_Ecosystems:_Laws_and_Science_in_the_Cross-hairs

**Extension:**

If possible, collect data on the levels of oxygen, carbon dioxide, and pH in the water above these sediments. These variables are strongly affected by the physical conditions in the water such as depth, turbidity, and temperature. Relate the types of living things in your habitat to these conditions.
What Does an Oceanographer Do?

By Scott Thompson

In conjunction with BOTTOMS UP Research Project

Grade Level: 9 – 12

Georgia Performance Standards: SCSh 1a-c; SCSh7 a-e; SCSh 8a-f

National Standards: Content Standard A

Type of Activity: Web Quest

Focus Question:
1. What are the types of oceanography careers?
2. How do oceanographers spend their time?

Objectives - The students will
1. Investigate and describe specific careers in oceanography.
2. Link the skills necessary to the tasks performed in different fields of oceanography.
3. Interview an oceanographer by e-mail.
4. Create a Help Wanted advertisement / profile for a specific type of oceanographer for a specific oceanographic institute, university, or aquarium.

Materials:
Internet access

Key Words
Oceanography
Marine geology
Coastal geology
physical oceanography
chemical oceanography
seismology

Procedure:
1. Branches of oceanography.
   Visit the Website “Sea Grant Marine Careers – Oceanography” at the web address http://www.marinecareers.net/field_oceanography.php to get an overview of oceanography careers. Then, click on the different fields of oceanography on the left side of the page and read about each field. Finally, click on “More Profiles” to read several profiles of different oceanographers.

2. Current Research.
   Then visit at least three of the websites below to find out the focus of current research at different institutes, universities, and aquariums. Find out what scientists are doing to study the ocean.
   - Woods Hole Oceanographic Institute - http://www.whoi.edu/
   - Skidaway Institute of Oceanography - http://www.skio.peachnet.edu/
   - COSEE SouthEast: http://www.cosee-se.org/
Observations:
1. Branches of Oceanography:
   Open a Microsoft Word document. Copy and paste the information of interest to you into your Word document. Please be sure to cite your information by copying the web address above your pasted information. This will help you to write your own Help Wanted poster.

2. Current Research:
   Once again, copy and paste information about current research topics from the website. Something to keep in mind – if you don’t understand what they are talking about, the information is probably not particularly useful. Try to interpret the information so that it makes sense to you. It may help to summarize the research topics briefly in your own words.

Conclusions:
1. Use the information compiled in your Microsoft Word document to create a Help Wanted poster for a position as an oceanographer. This should include:
   - a descriptive job title
   - the skills and level of education needed to perform the job
   - a detailed job description including duties to be performed
   - the expected time investments including field research expeditions
   - the salary range

2. In your own words explain the types of oceanographic careers and write in narrative form using complete sentences, examples, explanations, and appropriate vocabulary. Create a compelling and persuasive argument to attract the best qualified candidates.

Web Resources
- Careers in Oceanography, Marine Science & Marine Biology
  http://ocean.peterbrueggeman.com/career.html
- Oceanography at Palomar College – Careers in Oceanography
  http://www.palomar.edu/oceanography/links/Careers.html
- Interested in a career in oceanography? http://www.oc.nps.edu/careers.html
Conductivity of Salt Water

Original Activity by Karen Moyd adapted by Patricia DuBose
In collaboration with the BOTTOMS UP Research project

Grade Level: 9-12

Georgia Performance Standards: SPS6, SPS2

National Standards: Content Standard B

Type of activity: Lab

Focus Questions:
- How is salinity measured by researchers?
- What is the relationship between salinity and conductivity?

Objectives: The students will:
- Explain the relationship between conductivity and salinity in the marine environment.
- Identify methods researchers use for measuring salinity.
- Observe a decomposition reaction by identifying the products and reactants; and write a balanced chemical equation.

Materials for each lab station:
- 9 volt battery (use a national brand for better results)
- 2 lengths of bare wire (provide a variety for student choice … Al, Cu)
- Electrical Tape
- 2 test tubes
- 600 mL beaker
- Distilled water
- Salt (provide a variety for student choice … sea salt, table salt, kosher salt)
- Wooden splints
- Matches
- Graduated cylinder (for extension activity)
- Electronic balance/triple beam balance (for extension activity)
- Refractometer (for extension activity)

Key Words:
- Conductivity
- Salinity
- Electrolysis
- Law of Constant Proportions
- Refractometer
- Conductivity meter
- density
Background Information: Measuring concentration of solutes in the marine environment

The marine environment is different from freshwater environments in that the water holds a variety of solutes. The amount of solutes that can be dissolved in water depends upon the temperature of the water. The amount of solutes is usually expressed as salinity or density.

Salinity is a measure of the total number of solutes dissolved in one liter of solvent (water) and is usually represented in parts per thousand or ppt. Salinity can be measured in a variety of ways. Prior to the technological age, scientists used a known concentration of silver nitrate and titrated a sample of sea water until a white precipitate was formed. This white precipitate is silver chloride and a scientist could then calculate the concentration of sodium chloride in the sample. With this information the salinity could be calculated as the percentage of sodium chloride in the total concentration of solutes is always constant. This is known as the Law of Constant Proportions. This method of measuring salinity is not practical for the field research and yet another calculation would need to be made to determine the density. Density is the measure of amount of mass per unit of volume and is equaled to pure water having a density of 1 g/ml. The use of “wet” methodology in the field is often cumbersome and does not provide all the information needed. Many field researchers will use an instrument called a refractometer to measure the salinity as well as the density. The refractometer is based upon physical properties of light. When light passes through a small sample of water, it will be diffracted as it encounters a medium with a different density. Therefore, light passing through the instrument will diffract proportionally with the number of solutes (dissolved particles) and give a measure of both salinity and density. With the small sample size, evaporation will happen quickly and provide a source of error for these readings. Another source of error for this instrument would be any particulates suspended in the water column such as sediments, plankton or detritus. These particles would cause greater diffraction of light providing a slightly inaccurate reading. The preferred method for the marine researchers studying the open ocean for measuring salinity is using a conductivity meter. This meter measures the electrical potential of the solution. The electrical potential is directly proportional to the amount of disassociated ions in the water sample. Positive ions (cations) will be attracted to the negative terminal while the negative ions (anions) will move toward the positive terminal creating an electric current. Water without any disassociated ions will not measure an electrical potential. This method will not be affected by the suspended particles in the water column or by a variation in temperature. Parital salinity unit or psu is the unit given to the value when the conductivity meter is used to measure salinity. Researchers will also collected temperature data simultaneously in order to evaluate the density of the water sample.

Procedure:

1. Fill beaker with 400 mL of distilled water.
2. Wrap one length of wire around each of the battery terminals. Secure with electrical tape.
3. Label the test tubes with a + and – mark to indicate the appropriate battery terminal. Fill the test tubes with water, place your thumb over the open top, then invert the test tube in the beaker of water. Carefully insert the length (approx. 12 inches) of coiled wire into the
test tube. Repeat for the other length of wire. Make sure the bare wires are NOT touching.

4. Add salt to the beaker of water.
5. Allow the gases to collect until the end of the period or overnight.
6. Measure the length of the space above the water in each of the test tubes. Record your observations.
7. Carefully remove the positive terminal test tube gently, allowing the water to flow out without turning the test tube completely upward.
8. Identify the gas created by the positive terminal by inserting a glowing wooden splint into the opened end. If the glowing splint combust into a flame you have a positive test for oxygen.
9. Now carefully remove the negative terminal test tube gently, allowing the water to flow out without turning the test tube completely upward.
10. Identify the gas created by the negative terminal by bringing a flaming wooden splint to the mouth of the test tube. A positive result provides a brief “pop” sound. If you are careful to not turn the test tube completely upward on the first try, you may be able to control the gas escaping so that you may repeat the process several times. A positive result indicates the production of hydrogen.

Observations:

<table>
<thead>
<tr>
<th></th>
<th>Space (cm)</th>
<th>Reaction with glowing splint</th>
<th>Identification of gas collected</th>
<th>Type of Ion</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Test Tube</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Test Tube</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. How does the addition of the salt affect the water in the beaker? Explain.
2. What type of ion will be moving toward the + test tube? The – test tube?
3. Is the rate of gas production different on the two wires? Describe any differences.
4. How do the test tubes compare to one another from the beginning of the experiment to the end?

Conclusions:

1. Is the volume of space in each test tube the same? Explain any differences you have observed. Calculate the ratio of the two gases.
2. What gas was collected in the + test tube? Provide evidence to support your choice. Explain the source of this gas.
3. What gas was collected in the – test tube? Provide evidence to support your choice. Explain the source of this gas.
4. How is the amount of salt in the solution related to the rate of reaction?
5. How do scientists use this process in monitoring the salinity of marine ecosystems?
6. A marine science technician collected three samples from three different locations. Conductivity was measured for each sample as it was collected and the results were as follows:
   Sample A: 3.45 mV    Sample B: 7.08 mV    Sample C: 5.52 mV
On the way back to the laboratory, the truck had to stop suddenly and the sample bottles fell out of their labeled racks. Could you help the technician put the bottles back into the racks that were labeled: Beach; Pond; Tidal creek? Explain.

Extensions:

To Quantify the solute (salt):

- Calculate and accurately measure the amount of salt used in the beaker using % volume calculations or molar concentrations that would equate to different marine environments. Beaker A: 0 ppt salt; Beaker B: 15 ppt (1.5%); Beaker C: 35 ppt (3.5%)
- Students would verify their calculations with the instructor prior to preparing the solutions.
- Compare the amounts of gas collected in each concentration as well as the reaction rates in each. Students would write a balanced chemical equation to show the reaction that occurred in the beaker.

Using a refractometer:

- Students place a drop of water from their salt solution and record the density and salinity of the solution using a refractometer.
- Students will compare the rate of reaction to the values recorded from the refractometer to make an inference about the relationship between conductivity and salinity.
Plankton Activity Lab
Night and Day Comparisons
Original Activity by Jeff Graham adapted by: Ann M. Middleton
In collaboration with the “BOTTOMS UP” Research Project

Grade Level: 9-12

Georgia Performance Standards: SB 3a; SB 4a; SO 2d; SEV 1b; SEV 2d; SEV 3a; SEV 3d

National Standards: Content Standards A, C and D

Type of activity: Lab

Focus Question: How does the time of day affect the amount and/or types of Plankton in the coastal zone.

Objectives: The students will:
1. Identify types of plankton, either Phytoplankton or Zooplankton, utilizing the reference key found under web resources.
2. Determine how the amount of light (time of day) affects the numbers and types of plankton.
3. Research one phytoplankton and one zooplankton through the internet and write a paragraph describing the classification and characteristics of this plankton as part of the lab report.
4. Develop a hypothesis and conduct an experiment following the scientific method.

Materials:
- Plankton tow sample taken in the evening
- Plankton tow sample taken in the morning
- Droppers
- Microscope slides and cover slips
- Reference key for phytoplankton
- Reference key for zoo plankton
- Compound light microscope

Key Words:
Phytoplankton Zooplankton
oil sacs spines
flagella autotrophic
photosynthesis carbon fixation
detritus plankton tow
wet mount slide

Background Information: Plankton is a term used to describe the small microscopic plants and animals that float in the water, living as deep as the light can penetrate. Phytoplanktons are autotrophic plants living near the surface of the water. Phytoplanktons have adaptive features
that help them stay near the surface, such as **oil droplets**, and **spines** for increased surface area, along with silicon like shells. **Zooplankton** (animal plankton) feed on phytoplankton and will consequently travel to the surface. Zooplankton may have whip-like **flagella** or cilia to help with mobility. **Carbon is fixed** into glucose during the **photosynthesis** and is used in the formation of the protective shells of many of these microscopic organisms. The deceased plankton forms the **detritus** which settles to the ocean floor. A **plankton tow** is a net used to collect plankton in the water column. The plankton is then washed and filtered into collection jars, where it may be preserved for future study. Living plankton may also be microscopically observed by making a **wet mount slide**.

**Procedure:**
1. Make a wet mount of a sample from a plankton tow culture (daylight) and view under the microscope at low power.
2. Using a reference key for phytoplankton and zooplankton (see web resources), list and diagram the organisms that you find in your sample.
3. Using medium power, identify the characteristics of phytoplankton (oil droplet, spines, silicon shells) and zooplankton (flagella and cilia that adapt them to living near the surface).
4. Make a second wet mount sample of plankton tow culture (night) and view under low power.
5. Follow the same procedure that you did for the daylight tow.

**Observations:**
1. On a plain sheet of paper, sketch and identify at least 2 to 4 zooplankton and 4 to 6 phytoplankton from the daylight tow.
   - Use a reference key (see web resources) and note what power you observed them on. Your sketches should be detailed. Do not forget to note the adaptive characteristics that planktons have developed.
2. On a separate sheet of paper, sketch and identify at least 2 to 4 zooplankton and 4 to 6 phytoplankton from the evening tow.
   - Use a reference key (see web resources) and note what power you observed them on. Your sketches should be detailed. Do not forget to note the adaptive characteristics that planktons have developed.
3. Compare the types and numbers of plankton found in the night tow sample with the day tow sample.
4. Select one phytoplankton and one zooplankton and write a bulleted summary of important characteristics. This should be no more than ½ a page. The student will conduct a web search to complete this lab.

**Conclusions:** Summarize how the time of day affects the amount and/or types of plankton in the coastal zone? Did your experiment support your hypothesis? Explain your answer.

**Web resources:**
www.marine.usf.edu/pjocean/packets/f97plank_id.pdf
http://cfb.unh.edu/cfbkey/html/begin.html
Marine Equipment Booklet

Skidaway Institute of Oceanography
BOTTOMS UP
Marine Equipment Activities

Original Activity by Karen Moyd. Adapted by Ann M. Middleton. Illustrated by Olivia Moyd
In Collaboration with the “BOTTOMS UP” Research Project

Grade Level: 9 to 12

Georgia Performance Standards: SCSh 4

National Standards: Content Standard E

Type of Activity: Desk Activity

Focus Question: What types of equipment is needed on a marine research ship?

Objectives: The students will be able to:

1. Understand the types of equipment necessary for a marine research vessel.
2. Adequately identify and discuss how marine equipment is used.

Materials:

- Marine Science Equipment Reference Booklet
- Colored pencils (if desired)
- Flash cards hand out
- Marine Equipment puzzle

Procedures:

1. Each student will receive a marine equipment reference booklet containing sketches of marine equipment necessary for a research vessel to read and study. Using colored pencils, students can color the equipment pictures for their notebooks.
2. Students will work in pairs and quiz one another using the flash cards found in the booklet.
3. Students should answer the questions in the observations, then, complete the formative assessment crossword puzzle. This can be graded as a quiz or a test.

Observations: Answer the following:

1. Which instruments could be used to obtain data in reference to temperature, conductivity, and depth?
2. What could a scientist use to gather sediment samples from the ocean floor?
3. Name instruments used to gather data from the water column.
4. How are the naval towers powered?
5. Which instruments help to reduce classification time of specimens?

6. What device is used to open and close the doors on the instruments when they are at their designated depth?

7. What is used to transport scientists to and from research sites from the main ship?

8. What is used to anchor equipment to the ocean floor?

9. Which instruments measure chlorophyll content?

10. Describe the most important piece of equipment for a diver.

**Conclusions:** In your own words and in paragraph form write a summary of marine equipment and how it is used to conduct research onboard research ships.
A coring instrument removes 2.75 inches diameter by 13.75 inches sediment samples from the benthic region of the ocean
Found on the 7 naval towers and used to power instrumentation
Plankton Splitter

Can be used to cut classification time in half if calibrated properly
Transponder

Sonar Ping Instrument
Device used to open and close doors (SLED) at specific depth
SLED

Gathers benthic sediment/biologicals
Microscope/Dissecting Scope

Used to classify biologicals gathered from Plankton tow and SLED
Plankton Net

Used to capture plankton for microscopic examination at various depths in the water column

Pulled at: surface, 15 meters below, and 25 meters below
RHIB

Ridged Hull Inflatable Boat
Used for diving, instrument deployment, rescue operations and aids in assistance of any ship transport needs
Fishing Pole

The crew enjoys fresh caught fish on a routine basis
Instrument is used to collect water samples at any depth as programmed according to light sensor. Test for salinity (conductivity), particles, temperature, chlorophyll with a fluorometer and pressure. Additional instrumentation can be added.
ADCP (Acoustic Doppler Continuous Profile)

This is a current indicator which uses sonar to gather information on the speed and direction of the currents. It has an internal compass to acclimate it to magnetic north prior to deployment so that the correct direction can be determined.
HOBO Instrument

Programmed to collect temperature over extended periods of time at various depths dependent on location. It stores temperature data and is downloaded upon retrieval.
Mooring with CTD

This heavy metal base is used to anchor scientific equipment on the seabed. Instruments such as a CTD measure conductivity, temperature and depth over extended periods of time. To retrieve instruments from the mooring a transponder is used to release the buoy that returns the instrument to the surface.
US Navy TACTS
Tactical Air Combat Training System
R2 Tower

Naval tower used originally for weather tracking for ships. Scientists were granted permission to use the towers as a base location for the observatory set up.
This mooring is used to attach a sonar device that records seabed images.
Coring instrument

This is a drawing of the original coring instrument designed by Dr. Richard Janke. It is no longer used due to advancements in technology.
A CTD measures conductivity, temperature and depth.
The J-winches are used for deployment and retrieval of scientific equipment.
Carousel Deployment
Flourometer

The flourometer tests for light, pressure, chlorophyll, salinity (conductivity) and temperature at selected drop level.
Divers Oxygen Tanks

DO tanks contain a oxygen/nitrogen mixture. This is the breathing apparatus for scientific divers.
This instrument travels over a predetermined area of the ocean until it moves off course due to currents. Satellite tracking is critical for repositioning. The glider collects data for at least a month. Achieving neutral buoyancy is imperative prior to deployment.
SeaBat

This instrument is tethered to the boat and travels along the bottom collecting data.
<table>
<thead>
<tr>
<th>Oceanic Research Equipment Flashcards</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Coring Instrument" /></td>
</tr>
<tr>
<td>CORING INSTRUMENT</td>
</tr>
<tr>
<td><img src="image2" alt="Glider" /></td>
</tr>
<tr>
<td>GLIDER</td>
</tr>
<tr>
<td><img src="image3" alt="Wind Mill" /></td>
</tr>
<tr>
<td>WIND MILL</td>
</tr>
<tr>
<td>PLANKTON SPLITTER</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>TRANSPONDER</td>
</tr>
<tr>
<td>SLED</td>
</tr>
</tbody>
</table>
MICROSCOPE
DISSECTING SCOPE

PLANKTON NET

RHIB
(Rigid Hull Inflatable Boat)
<table>
<thead>
<tr>
<th><strong>FISHING POLE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>![Fishing Pole Image]</td>
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<table>
<thead>
<tr>
<th><strong>CAROUSEL</strong></th>
</tr>
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<tbody>
<tr>
<td>![Carousel Image]</td>
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<table>
<thead>
<tr>
<th><strong>ADCP</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(Acoustic Doppler Continuous Profile)</td>
</tr>
<tr>
<td>![ADCP Image]</td>
</tr>
<tr>
<td><strong>HOBO INSTRUMENT</strong></td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td><strong>MOORING WITH CTD</strong> (Conductivity, Temperature, Depth)</td>
</tr>
<tr>
<td><strong>US Navy TACTS</strong> (Tactical Air Combat Training System) R2 TOWER</td>
</tr>
</tbody>
</table>
SEA BED IMAGING MOORING

CORING INSTRUMENT

CTD
J-WINCH

CAROUSEL DEPLOYMENT

FLOUROMETER
| SkIO WATER TOWER | DIVERS OXYGEN TANK | SEABAT |
**Oceanic Research Equipment**

**ACROSS**
6. Collects microscope biologicals in water column.
7. Main operations area for ship.
9. Round compartmentalized device that collects water samples at various depths.
10. Measures conductivity/temperature/depth
13. Sonar pinging instrument used to open and close doors of equipment.
14. Magnifies biologicals for classifying taxonomically correct.
15. Free Space
16. Gathers sediment/biologicals from seabed
17. Acoustical Doppler Continuous Profiler
18. Test for pressure, chlorophyll, conductivity, temperature
19. Removes 2.75 inches diameter by 13.75 inches sediment samples from the benthic region of the ocean.

**DOWN**
1. Ridged Hull Inflatable Boat
2. Autonomous device that "flies" through the ocean due to variance in weights.
3. Heavy metal base used to anchor scientific equipment on the seabed.
4. Toggled to ship and collects benthic data
5. Supplies fresh water to Skidaway Island SKIO
8. Gathers biologicals from the water column.
12. Used to feed scientist and crew while at sea.
Oceanic Research Equipment Answer Key

ACROSS
6. Collects microscope biologicals in water column.
7. Main operations area for ship.
9. Round compartmentalized device that collects water samples at various depths.
10. Measures conductivity/temperature/depth
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You Don’t Always Take What You Need?
*Original Activity by Karen Moyd; adapted by: Lonnie Breslow
In collaboration with the Bottoms Up Research Project*

Grade Level: 9-12

**Georgia Performance Standards:** SCSh8 a, b, c, d, e, f

**National Standards:** Content Standards A and E

**Type of activity:** Lab-discussion

**Focus Questions:**
1. Based on the equipment preview and discussion activity, what would you need to have aboard ship to complete a successful 3 day-night research cruise?
2. How do scientists decide what equipment to take?
3. Who makes the decisions on what to take?

**Objectives:** Students will be able to:
1. Make a list of the necessary items that will be needed aboard ship during a research cruise.
2. Categorize all needs into several major groups such as human needs, ship needs, equipment needs, research needs.

**Materials:**
- several large sheets of white writing paper
- several differently colored pens, pencils or markers to identify each of the participants.

**Key Words:**
categorize  mission
sort  collaborate
research cruise

**Background Information:**

*The previous activity and the marine equipment booklet contains many suggestions for equipment that could be used during a research cruise.*

When planning a research cruise it is advantageous to list the necessary items needed so you can successfully complete your mission. To minimize having a lack of the proper supplies and equipment it may be beneficial to brainstorm or collaborate with the group and come up with a list of necessities or requirements. It is also advisable to categorize and sort your needs. Once at sea some equipment may require modifications so the materials to fabricate the changes should be considered. It is always a good idea to anticipate events that may happen and to carry extra supplies to fully maximize the cruise time.
Procedure: Part 1

1. Give each student a different colored marker, pencil or pen. Their color will serve as their identification of participation.
2. Write the 4 main categories (human needs, ship needs, equipment needs, research needs) onto a large sheet of paper.
3. Each student will have 30 seconds to write as many needs as they can on each display sheet. After 30 seconds, call time and instruct the students to move to a new sheet. Continue until each student has contributed to each of the 4 sheets.
4. As a class review the lists and to make any necessary adjustments.
5. Students will discuss the impact of the items they may have omitted on the success of their research cruise.

Procedure: Part 2

1. Divide the class into groups of 4-5 students. Each team will invent a specific mission for the ship (including time), decide on the size of the crew, and then repeat the procedure listed in part 1. Students should use the marine equipment booklet to help them.

Observations:

1. If you were going on a research cruise, should you consider making a list of items you needed to take with you?
2. Would you go over the list with someone else to get their opinion?
3. If your safety or the success of your cruise was in question would you rely on others for their advice?
4. Why might the success of your cruise be compromised by a lack of equipment?
5. What may be the advantage of makings lists as a group when planning a cruise or anything else for that matter?
6. Would it be helpful to know the purpose of your research cruise? Why might it be helpful?
7. Why might knowing the length of time of your cruise be advantageous?

Conclusion:

Compose a 3 paragraph summary including the type of mission your group has planned, what you agreed upon as necessities for success, and how your team plans to utilize the data gathered once you are back on land.
THE ‘PLAIN’ FACTS
Original Activity by Lonnie Breslow
In collaboration with the BOTTOMS UP Research Project

Grade Level: 9-12

Georgia Performance Standards: SO 1c, SO 2d, SES 2b, SES 3e

National Standards: Content Standard A and D

Type of activity: Lab

Focus Questions: How can we simulate the formation of the abyssal plain from top to bottom?

Objectives: Students will be able:
1. To create a three dimensional scale model of the abyssal plain in the Atlantic Ocean.
2. To describe how sedimentation, over long periods of time, can evolve into a 1,000 meter layer of sediment covering all types of sea floor topography
3. To conclude that the abyssal plain is a flat, expansive, extension of the sea floor between the continental rise and the mid-ocean ridge
4. To understand the difficulty of sampling, viewing, and studying this region of the ocean.

Materials:
- Large clear plastic container, fairly high sided ex. 2’x3’x12” high
- Styrofoam or plastic material such as modeling (to make the seafloor features)
- Permanent markers for coloring the features
- Scissors or plastic knives for cutting the Styrofoam or clay
- Adhesive for adhering the topographical features to the container bottom
- Lots of sand in several colors and grain sizes to represent different types of detritus and sediment.

Key Words:
- Continental margin
- Abyssal plain
- Divergent tectonic plate
- Continental rise
- Ocean floor
- Topography
- Sediment
- Wave action
- Phytoplankton
- ROV
- Submersible
- Satellite imaging
- Echo sounding
- Seamounts
Background Information:

The ocean floor, especially in the Atlantic, extends from the continental rise at the base of the continental margin across a large expanse of ocean floor to the mid-ocean ridge which is formed by divergent tectonic plates. The original sea floor topography including old volcanoes, guyots and seamounts will be covered, over time, by huge amounts of sediment and detritus. Since the depth is so great, wave action does not exert much influence on this layer. The result is a vast flat plain in which once prominent topographical features have been blanketed by millions of tons of sediment. The rate of accumulation is affected by many variables such as the sizes of algal blooms and the varying populations of phytoplankton and zooplankton which grow, die and settle to the bottom, as well as currents carrying large amounts of continental sediment. Because of the great depth of this layer it is difficult to study or sample the area. The use of remotely operated vehicles (ROV’s), autonomous underwater vehicles (AUV’s,) and manned submersibles along with satellite imaging and echo sounding are common means of study of deep water sediments.

Figure 1: Cross-section of ocean floor. Illustration and explanation taken from:
http://www.msstate.edu/dept/geosciences/CT/TIG/WEBSITES/RESEARCH/Christine_Oxenford/index.html

Extending out from a continent's edge is a gently sloping, shallow area called the continental shelf (F). At the edge of the shelf, the ocean floor drops off in a steep incline called the continental slope (A). The continental slope marks the true edge of the continent, where the rock that makes up the continent stops and the rock of the ocean floor begins. Beyond this slope is the abyssal plain (C), a smooth and nearly flat area of the ocean floor. In some places, deep, steep-sided canyons called trenches (G) cut into the abyssal plain. A continuous range of mountains called the mid-ocean ridge (D) winds around Earth. There are mountains on the abyssal plain, too. Some reach above the ocean surface to form volcanic islands (E). Others, called seamounts (B), are completely under water.
**Procedure:**
1. In this activity, students are to build a model of the ocean floor as close to scale as possible. Prior to beginning the activity, the instructor together with the class should determine the scale to be used. This will allow a standard to be set for all students to use. There are diagrams and tables in most oceanography texts that will provide measurements and data that will aid in determining a scale to be used. Figure 1 and 2 can be used to decide on what features are necessary for the model and an appropriate scale.
2. Mold or cut out the ocean floor features.
3. Place or attach the features onto the bottom of the container to accurately depict the sea floor from the rise to the mid-ocean ridge. Be sure that the following features are included: continental rise, guyots, seamounts, and the mid-ocean ridge.
4. Measure the heights of these features and create a cross-sectional profile or drawing onto which to record your data.
5. Add water slowly to the container until the level is within 3 inches of the top and all of the topography is submerged.
6. Each day or over a designated period of time representing a number of years, add a pre-measured container of sand by spreading the sediment out over the container and allowing it to settle over the ‘sea floor’. Continue this long enough for all the features become blanketed by the sediment. (Note: it may take a day for the sediment to completely settle onto the ocean floor model).
7. On the following day or after the sediment has settled to the bottom, record the sediment depth onto your cross-sectional profile or drawing. Be sure to record both the amount of sediment added each time and the depth of the sediment on the ocean floor model.
8. **Note:** the sand or material used may be of different colors or sizes to represent different types of sediment. The students should decide and record what color represents which type of sediment before they begin to add the sediments. This may present an opportunity for a coring lab as an extension to this activity.

**Observations:**
1. How did the sediment accumulate onto the sea floor as you added it daily?
2. What did the varying colors and sizes of sand particles represent in your model?
3. What was your designation of time span?
4. How might you obtain a core sample from the areas A-G indicated in the diagram above from your model?
Conclusions:

In your own words and in paragraph form explain how sedimentation, over a period of time, is able to transform the topography of the ocean floor into a flat expanse of ocean bottom? Explain why studying the abyssal plain may prove difficult.

Extensions:

- A coring activity might be planned as an extension.
- A current or wind generator may be used to show their respective impact on the seafloor.

Web Resources:

- http://www.ngdc.noaa.gov/mgg/image/global_grav_large.gif
- http://earth.google.com/ocean/
Five Flavor Lifesaver

*Original activity By Karen Moyd adapted by Scott Thompson
In conjunction with BOTTOMS UP Research Project*

**Grade level:** 9-12

**Georgia Performance Standards:** SPS 2a; SCSh 2a, b, c; SCSh 5a, b, c, d, e

**National Standards:** Content Standard A and B

**Type of Activity:** Lab, Hands-on

**Focus Questions:**
1. How does salinity affect the density of water?
2. How does salinity affect the movement of ocean water?
3. How does the movement of ocean water affect climate and the quality of life on earth?

**Objectives:** The students will be able to:
1. Define concentration and apply this definition to salinity in the ocean.
2. Express concentration in metric units.
3. Prepare solutions having different densities.
4. Measure the densities of each solution.
5. Demonstrate how solutions having different densities interact.

**Materials:**
Each lab group should have the following
- 100 ml graduated cylinders,
- 10 ml graduated cylinder or a test tube
- Table salt
- Distilled water
- Triple beam balance or mass measuring balance
- 5 - 250 ml containers (cups or beakers)
- red, green, blue, and yellow food coloring

**Key Words:**
Mass volume
Density salinity
Convection currents dissolve
Solution density
Concentration North Atlantic Conveyor Belt

**Background Information:**

*Density* is a ratio of **mass** per unit of **volume**. This can be express mathematically as

\[
\text{Density} = \frac{\text{Mass}}{\text{volume}}
\]
The more dense an object or substance is, the greater its mass compared to its volume. The density of ocean water is an important physical factor determined by both salinity and temperature. Colder water is denser than warmer water. Also, the more salt dissolved in the water, the greater the density. Water having a higher concentration of dissolved material tends to sink because of its greater density. The salinity of ocean water is determined by several factors including the influx of fresh water from rivers, the rate of evaporation in warmer latitudes, and the freezing of sea water in colder latitudes. As sea ice forms, the salt left behind causes the water to become even saltier. This makes polar water denser. The water sinks creating convection currents that drive many important deep water ocean currents. Along with the Gulf Stream, this sinking deep water current, called the North Atlantic Conveyor Belt cycles water from the equator to the poles and back. This is a critical factor in climate by also distributing heat from the equator toward the poles making many northern areas warmer than they would be otherwise.

This experiment simulates the relationship between salinity and density in the ocean. Salinity in the oceans ranges from 20 - 38 grams of salt/1000 g water (parts per thousand or ppt). While the ocean does not contain water of such high concentrations as the solutions you will prepare, the principles and the effects are the same. Those effects have a direct influence on the quality of life.

Procedure:

**Part I: Measuring and computing density of different solutions.**

1. Obtain five 250 ml containers and label them A - E.
2. Add 100 ml of distilled water to each container.
3. Add measured amounts of salt to your containers.
   a. To container A, add 0 g of salt;
   b. To container B, add 6.25 g of salt stirring as you add.
   c. To container C, add 12.5 g of salt stirring as you add.
   d. To container D, add 25 g of salt stirring as you add.
   e. To container E, add 50 g of salt stirring as you add.
4. Mass a 10 ml graduated cylinder. Record in the data table below.
5. Pour approximately 8 ml of sample 1 into the graduated cylinder. Mass the sample and subtract the mass of the cylinder to get the mass of sample 1. Record this in the table below.
6. Read the volume of sample 1 directly on the graduated cylinder. Record in the table below.
7. Discard your sample, rinse the graduated cylinder, and repeat this step for the remaining samples. Remember to subtract the mass of the cylinder before recording in the data table.
8. Compute the density of each sample using the formula above and record in the data table.
Part II: Comparing the density of different solutions.

1. Color your solutions using food coloring:
   a. Add 10 drops of red food coloring to the beaker containing sample (A) and stir to mix.
   b. Add 5 drops of red food coloring and 5 drops of yellow food coloring to the beaker containing sample (B) and stir to mix.
   c. Add 10 drops of yellow food coloring to the beaker containing sample (C) and stir to mix.
   d. Add 10 drops of blue food coloring to the beaker containing sample (D) and stir to mix.
   e. Finally, add 10 drops of green food coloring to the beaker containing sample (E).

2. Put one pipette in each container.

3. Using the pipette provided, slowly add each solution drop by drop down the side of the cylinder in the following order:
   a. 2 ml of solution (E) to the 10 ml graduated cylinder or test tube.
   b. 2 ml of solution (D) to the 10 ml graduated cylinder or test tube.
   c. 2 ml of solution (C) to the 10 ml graduated cylinder or test tube.
   d. 2 ml of solution (B) to the 10 ml graduated cylinder or test tube.
   e. 2 ml of solution (A) to the 10 ml graduated cylinder or test tube.

Observations:

Part I:

Mass of 10 ml graduated cylinder: ________

<table>
<thead>
<tr>
<th>Sample</th>
<th>Solution</th>
<th>Mass (g)</th>
<th>Volume (ml)</th>
<th>Density (g/ml)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>0 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>6.25 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>12.5 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>25.0 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>50.0 g</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Part II:

Use markers or colored pencils and additional paper to draw your observations after you have added all the solutions.
Conclusions:

In your own words, write a paragraph or two that explains the questions below.
1. What patterns did you observe in your data?
2. What is density and why is saltier water denser than water containing less dissolved material?
3. Where did the salt in the oceans come from? What factors affect the salinity of ocean water?
4. How does salinity affect the movement of ocean water?
5. Why are ocean currents important to weather and climate?
6. Why are ocean currents important to living things?

Extension:

1. What would happen if you released one drop of each color into the tower of colors in separate intervals?
2. How do the results of extension 1 reflect information in reference to the North Atlantic Conveyor Belt?
3. What would happen if you shake the color tower? Explain.
4. How could you insert yellow into your color tower if you had accidentally left it out?

Web Sources:

- Ocean Odyssey – You Tube Deep Current Animation - http://www.youtube.com/watch?v=FuOX23yXhZ8
- PhysicalGeography.net - http://www.youtube.com/watch?v=FuOX23yXhZ8
Core Sampling Simulation
By Scott Thompson
In conjunction with the BOTTOMS UP Research Project

Grade Level: 9 – 12

Georgia Performance Standards: SO1 c and d; SO2 b, c, d, e; SO5 a, b, c, d; SB4 a and b

National Standards: Content Standard E

Type of Activity: Lab, Hands-on

Focus Questions:
1. What biotic and abiotic factors are present on the continental shelf ocean floor?
2. How do biotic and abiotic factors interact to create marine food webs?

Objectives: The student will:
1. Infer from populations of marine flora and fauna the physical conditions that give rise to these populations.
2. Relate the importance of species that dwell in ocean sediments to the overall health of marine ecosystems.

Materials:
- 10 gallon plastic container or aquarium or several glass 1000 ml beakers
- clear large gauge drinking straws
- glitter
  - green represents green marine algae
  - red represents diatoms
  - gold represents dinoflagellates
- grits (represent copepods)
- rice (represents mollusks)
- very small plastic beads
  - blue = sponges
  - red = echinoderms
  - black = octopus
- bb’s (represent polychaetes)
- coarse and fine sand (represent different size sediment particles)
- diatomaceous earth (at your local pool store – you can use it for years) (represents very fine sediment particles)
- compass
- protractor
- ruler
- play dough
Key Words:

diatoms  dinoflagellates  benthic
phytoplankton  Zooplankton  copepods
sponges  Schaphopods  dead zones
barnacles  brachiopods  ecosystem
amphipods  echinoderms  diatomaceous earth
mollusks  sea squirts  population
isopods  polychaetes  producers
food web  ecological niche  consumers
energy pyramid  octopus  biodiversity

Background Information:

Populations of producers and consumers in this ecosystem are critical to global marine ecosystems. Abiotic physical and chemical conditions present in the ocean determine the health and viability of benthic ecosystems. For example, an overabundance of nutrients from fertilizer runoff or livestock farms may cause some algae to thrive at the expense of others. This may lead to a reduction of biodiversity or the introduction of toxins such as those caused by red tides. Excess sediment from erosion and runoff can reduce penetration of sunlight causing reduction of phytoplankton (such as diatoms and dinoflagellates) and zooplankton. Insoluble toxic sludge can create dead zones where little or no life can be found.

The purpose of this activity is to simulate relationships revealed by core samples from the ocean floor. Sediment size is a function of the energy of the vectors that deposited it and the currents or waves that interacts with it. The distribution of sand, diatomaceous earth, and living things in a container or aquarium should simulate the different conditions described in the above paragraph. For example, high energy deposition results in larger sediment particles while low energy results in finer grained sediment. Also, a healthy ecosystem will have a range of producers that include all representative algae. Each successive layer contains only about 10% of the energy found in the level below it. Items added to represent numbers of individuals organisms should be distributed accordingly so that different conditions are represented. Students should infer these conditions from their results.

Procedure:

1. Research Component:
   - Conduct internet research about the flora and fauna of the continental shelf sea floor using the key words above. Explain the ecological niche of these organisms and indicate which are autotrophs or heterotrophs.
   - Create a probable food web and an energy pyramid that links sediment dwellers to the more renowned ocean species such as sharks, tuna, and squid.
   - Copy and paste your research into a Microsoft Word document. Include the web address, names, and titles for each source of information.
   - Copy and paste pictures and diagrams of these organisms along with this information. Print these along with pictures of organisms.
1. **Core sampling component:**
   - Your teacher has created a simulated sea floor in an aquarium. Use a straw to “sample” the sea floor by plunging it into the sediment in the aquarium.
   - Carefully remove the straw so that you capture a sediment core.
   - Draw a grid 1 cm to a side on the bottom of your Petri dish.
   - Place the *bottom half* your sample in the dish and spread the sample so that you can clearly see the different components and your grid lines.
   - Repeat this for the top half of your sample and record in Table 1b.

**Observations:**

**Sediment analysis:**
1. Use tally marks to count sediment particles in two of the grids on your dish. Then extrapolate an estimate of the proportions of each sediment particle size by computing the percent of each.
2. Create a circle graph of this data.

**Biotic survey:**
1. Count the different types of living organisms in your sample.
2. Make your own data table for tally marks for each type of living thing listed above that you see.
3. Once again, compute the percent of each type present.
4. Create a circle graph of this data.
5. Compare your data to that obtained by student group that sampled in another part of the aquarium and describe this in the space below.
6. Create a food web or energy pyramid of your benthic sample.

<table>
<thead>
<tr>
<th>Table 1. Sediment sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Bottom half of sample</td>
</tr>
<tr>
<td>Grid</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Top half of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>
Comparison of your data:

Conclusions:

Use research from the Web Resources below to write at least 2 paragraph summary that address the ideas or questions below. Please use your own words, complete and accurate scientific explanations, examples, and appropriate vocabulary.

- Explain your food web or energy pyramid:
  - Why must producers represent the bottom of the web or pyramid?
  - Why is there less energy at successive trophic levels in the web or pyramid?
  - Why are the numbers of individuals fewer at the upper levels of the web or pyramid?
- How do your results compare to those from other students that sampled in a different part of the aquarium?
- What abiotic factors might contribute to the differences between the two samples?

Web Resources:

Marine Fisheries Food Webs
http://oceanworld.tamu.edu/resources/oceanography-book/marinefoodwebs.htm

The Marine Food Chain
http://drake.marin.k12.ca.us/stuwork/ROCKwater/PLANKTON/Food%20Chain.htm

Fitting Algae Into the Food Web
http://www.bigelow.org/edhab/fitting_algae.html

Extensions:

- Have students research and report on the causes and effects of increasing incidence of harmful algal blooms worldwide.

- Have students research the causes and effects of the dead zone in the Gulf of Mexico. http://serc.carleton.edu/microbelife/topics/deadzone/
Build a Glider

Original Activity by Karen Moyd
In Collaboration with the “Bottoms Up” Research Project

Grade Level: 9-12

Georgia Performance Standards: SCSh 1, SCSH 3, SCSh 4c

National Standards: Content Standard E

Type of activity: Inquiry lab

Focus Question: How do you construct a glider that achieves neutral buoyancy in both fresh and salt water?

Objectives: Students will:
1. Discuss content in relation to the need for neutral buoyancy for oceanic deployment of instrumentation such as a glider.
2. Design and construct a glider which is neutrally buoyant in fresh water.
3. Make necessary adjustments to enable the glider to remain neutrally buoyant in salt water.
4. Understand some of the frustrations that research scientist face when testing their instruments.

Materials:
- Popsicle sticks (large and small)
- rubber bands
- Electric tape (waterproof tape)
- pipe cleaners
- Zinc washers and bolts (weight)
- non-biodegradable Styrofoam peanuts
- Kite string
- small pieces of scrap wood
- Straws
- plastic utensils
- 2-5 gallon tubs of water
- 1 box of salt
- Student Worksheet (one per student)

Key Words:
- Glider
- Density
- Neutral Buoyancy
- Salinity
- Glider (oceanic)
- Satellite control

Background Information:

Underwater gliders are autonomous vehicles (AUV’s) that can move vertically and horizontally on wings. In order to do this, the glider must obtain neutral buoyancy so that they float just below the water’s surface but do not sink. Gliders propel themselves by changing buoyancy and using wings to produce forward motion. Buoyancy is changed by varying the mass elements from the front to the rear of the glider.
Upon surfacing the gliders have contact with satellite control mechanisms to reposition them if off course. The cost of production of gliders is tremendous. Should the glider prove not to be neutrally buoyant upon the onset of deployment great monetary losses are incurred. As the salinity (\% of salts) in the water change so does the density (mass/volume) directly. As the gliders are moved from one location in the ocean to another the buoyancy must be reconfigured. This is often frustrating to the research scientists especially if only a milligram or two of additional mass is required.

Procedure:

1. Prior to the class fill two 5 gallon tubs with water. In one tub dissolve 1 box of salt. Label the tubs: Fresh Water and Salt Water.
2. Place all the materials listed above on a table.
3. Divide the class into groups of 2-3 students each.
4. Tell the students that they are to build a glider that will be neutrally buoyant first in fresh water then in salt water using only the materials provided.
5. Each group should test their gliders and make needed adjustments until neutral buoyancy is achieved in the fresh water.
6. Groups then test their glider in the salt water tub. Additional adjustments will be needed. It is helpful to tie kite string to the balance point of the glider to insure safe retrieval.

Observations:

1. How did your glider perform in the fresh water?
2. How did you glider perform in the salt water?
3. Did you meet any frustrations? If so, what?
4. What might you suggest could be added to the list of materials to aide in success of this project?
5. Do you have a better understanding of the frustrations of a scientist research at sea with a glider?

Conclusions:

In a paragraph, describe how you constructed your glider to achieve neutral buoyancy. Explain any frustrations you encountered in detail. Describe how you think a research scientist might feel when they encounter the same challenges you did, but they are at sea on a research vessel and their equipment that is certainly much more expensive?

Web resources:

www.physics.mun.ca/~glider/
www-pord.ucsd.edu/~rdavis/publications/MTS_Glider.pdf
www.unc.edu/~credward/cv.html
Glider Activity – Students Worksheet

Name __________________________

Date ___________________________    Partners: ________________

Problem: _____________________________________________________________?

Hypothesis: ________________________________________________________.

Materials: (List in 2 neat columns.)

Procedure: (List steps in a column with numbers.)

Data: Name, draw, and color your final product:

Conclusion: Answer the following on the back. Number your complete sentences.

1. Explain how your glider performed in the fresh water?
2. When you changed over to the salt tank, what did you have to modify on your
glider in order to make it work?
3. What is neutral buoyancy?
4. What type of frustrations could you perceive a scientist encountering while at
sea in reference to neutral buoyancy and using a glider?
5. What is your opinion of this lab and working with your lab partner?