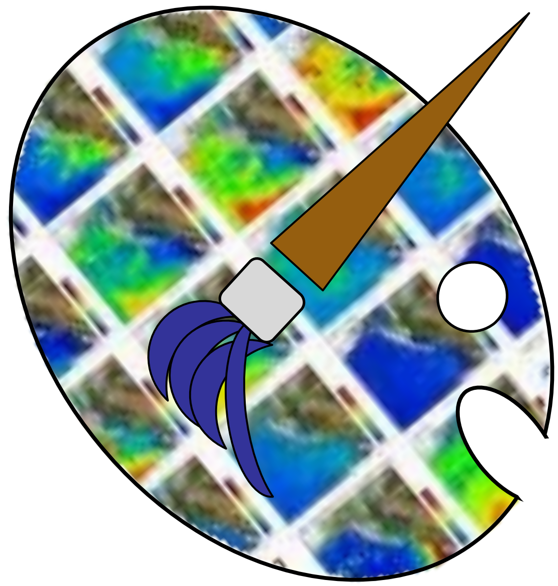

The Artistic Oceanographer Program: Encouraging ocean literacy through multidisciplinary learning

Program Handbook: C-MORE Edition (v.1)

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Reference: S. T. Haley and S. T. Dyhrman (2008) The Artistic Oceanographer Program: Encouraging ocean science literacy through multidisciplinary learning. Science and Children. (A Journal of the National Science Teacher's Association) 46:31-35

Funding for this handbook provided by the National Science Foundation
Center for Microbial Oceanography: Research and Education (C-MORE)

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Background

A central challenge in science education is to provide better, more engaging techniques for learning. In recent years, hands-on learning has become a popular method to address this challenge. Hands-on learning, which provides learning by doing, helps a student to acquire knowledge and skills outside of books and lectures, occurs through work, play, and other life experiences. Through hands-on learning, students are afforded numerous benefits, including increased: 1) retention of content; 2) motivation to learn; 3) enjoyment of learning; 4) proficiency and communication skills; and 5) independent thinking and creativity. Moreover, the hands-on approach often mandates the collaboration of educators from two or more disciplines for a comprehensive and systematic approach to skills development.

The Artistic Oceanographer Program is a hands-on, multidisciplinary program designed to engage elementary school students (5th graders) with diverse learning styles and interests in ocean sciences. Originally piloted in 2006, the program was developed and designed to innovatively and effectively couple short presentations, hands-on laboratory work, and art, to engage students in the understanding of ocean science, and microbial oceanography in particular.

The Artistic Oceanographer Program involves the pairing of two seemingly disparate disciplines: science and art. The Program dedicates four days (one hour per day) to hands-on lessons on the ocean (e.g., characteristics and importance) and microbial oceanography (e.g., the role of microorganisms in the structure and function of marine ecosystems). The science lessons consist of a brief lecture or demonstration, provided by faculty and staff from the supporting Institution. There is an inquiry-based laboratory component each day for students to look at, and try to identify, different types of microorganisms (phytoplankton) using microscopy. Additionally, one class is dedicated to learning about the many uses for phytoplankton or algae in the home, and this includes the chance to taste algae-derived ingredients used in items such as chocolate milk.

The art component of the program is accomplished by devoting one of the four class periods to an art class, allowing the students to draw a picture based on what they observed under the microscope. Using media of their choice, the students work with their art teacher and visiting researchers to design their own phytoplankton species. Students are asked to give their new organism adaptations that will help it survive and to give it a name (genus and species). This creative exercise gives students an opportunity to document what they observed under the microscope, reinforce what has been presented to them in a lecture format, and also engage those students with different learning styles.

The Program is aligned with 5th grade curriculum standards for the four states -- California, Hawaii, Massachusetts, Oregon -- that host C-MORE partner institutions. The science-based portion of the project is designed to mesh well with standards that emphasize adaptations of living things to their environment, energy and living things (e.g., food chains), and the characteristics of plants. the art exercise adheres to standards that require the creation of 2D representational artwork from direct observation (Appendix II).

The Artistic Oceanographer program has been running for three years at a school in Falmouth, Massachusetts for several classes of 5th graders and has proven to be highly successful in several ways. First, based on feedback from students, the program is effective in piquing their interest in the oceans, with nearly 100% of the students reporting that they wanted to learn more about the ocean. Second, it provides considerable opportunities for hands-on learning. For many students, this program provided the first opportunity to use a microscope. One student exclaimed, while watching phytoplankton move around under the microscope, “This is better than TV!” Third, it promotes learning science through art. In fact, multiple students listed their favorite part of the program as getting to draw phytoplankton. Last, the program promotes the collaboration of educators from science and art and establishes a partnership between local schools and research Institutions. This handbook serves as the first template for guiding researchers in the implementation of the Artistic Oceanographer Program.

Alignment with C-MORE’s mission

The Center for Microbial Oceanography: Research and Education (C-MORE: cmore.soest.hawaii.edu) is a NSF-sponsored Science and Technology Center designed to facilitate a more comprehensive understanding of the diverse assemblages of microorganisms in the sea. The Center’s activities are coordinated among six partner institutions located in four states:

- Massachusetts Institute of Technology (MA)
- Woods Hole Oceanographic Institution (MA)
- Monterey Bay Aquarium Research Institute (CA)
- University of California at Santa Cruz (CA)
- Oregon State University (OR)
- University of Hawai‘i at Manoa (HI)

One of the missions of C-MORE is to support the education of a diverse group of people (e.g., students, educators, researchers and the public) in microbial oceanography. According to the C-MORE Strategic and Implementation Plan (SIP) for 2007-2008, the Center intends to lead efforts in increasing understanding and appreciation of microbial oceanography, with the intention of promoting knowledge and awareness of ocean microbes, their key roles in ocean processes, and their essential roles in the habitability and sustainability of life on Earth. The Artistic Oceanographer Program is a microbial oceanography outreach curriculum congruent with the mission outlined in the C-MORE SIP for use by partnering C-MORE institutions. As such, the program satisfies one of the two C-MORE education goals: to increase scientific literacy in microbial oceanography (SIP Section 3.4, Goal A). The Artistic Oceanographer Program also satisfies a number of C-MORE’s education objectives (SIP Section 3.4). These include:

Objective A – Disseminate the fundamental concepts that constitute scientific literacy in microbial oceanography to the public. The Artistic Oceanographer Program meets Objective A by addressing the following key concepts in microbial oceanography:

- Microbes are everywhere and are diverse.
- Microbes are essential in the food web.
- Microbes have a significant impact on our global climate.
- Microbes are important to humans for food, biofuels, medicines, etc.

Objective B – Improve, update and disseminate K-12 activities and other instructional resources in microbial oceanography.

Objective C – Encourage and support teachers to incorporate microbial oceanography into their disciplines. The Artistic Oceanographer Program is well suited to satisfy Objectives B and C. It is an innovative, multidisciplinary approach to teaching microbial oceanography to 5th grade students. It also fosters a partnership between the research institution staff and the teachers and students. Certainly, the pilot program has served to disseminate and improve instructional resources in microbial oceanography in the Falmouth, MA school district.

Making Contact

Pre-Visit Planning with the Teacher(s) – adapted from TERC, an education research and development organization (www.terc.edu), and the New England Centers for Ocean Science Education Excellence (www.necosee.net).

Planning with the teacher before your visit is the most effective thing you can do to help make your visit a success. An essential part of this planning is one or more conversations (via phone or personal visits) with the teacher in which you find out more about the students, what they are studying, and what the classroom situation is like. You should discuss some fairly specific ideas about what your visit will accomplish. This program adheres well to many science and art education standards (see Appendix II for standards specific to your state) and these can be used as a conversational selling point for implementing the Artistic Oceanographer Program in the classroom.

Questions for the researcher to ask the teacher during a pre-visit phone call or visit (see Appendix III for a Q & A worksheet):

1. Program overview and goals: Begin by introducing the program, sharing with the teacher what the program is about, its history, goals, and benefits. Detail how it fits with current state standards.
2. Teacher feedback: Ask the teacher for some feedback. Do you think the students would be interested in this? Would it fit in with what you are teaching? What do the students already know about this topic?
3. Basic orienting questions: What grade level is this class? How much time will I have? How many students are in the class? What's the arrangement of the desks in the classroom?
4. Special situations in the classroom: Are there any special needs the students may have in the classroom (e.g., learning or physical disabilities)?
5. Science curriculum for the year: What are your students learning now? What science will be covered over the course of the year?
6. Teacher's goals: What would you like the students to learn from this experience? Or, what would you like the outcome of this visit to be for your students? This is a good time to also talk about assessments and enrichments (pages 14-16 of this handbook).
7. AV tools: What is the availability of TVs, digital projectors, computers, internet connection, carts, projection screens, etc?
8. Access issues: Are there any administrative or security issues for your visit that need to be addressed? What are the restrictions for bringing equipment, water samples, food, etc onto school grounds that could be problematic?

Program Overview

- Grade Level: 5
- Subjects: Science, Art
- Duration of lesson: Four 60-minute sessions

Overall Goals

- Students with diverse learning styles and interests will learn the importance of the oceans and their microscopic inhabitants (e.g., phytoplankton) through the pairing of science and art.

Prerequisites

Classroom:

- Lecture space suitable for short presentations – This can easily be done in the classroom. However, it is most time effective and less distracting to have this area separate from the lab work space. By having separate areas for the lecture and the lab, the students can quickly move from one area to the other without having equipment or demonstrations be set up around them at their desks.
- Work space suitable for using microscopes – The best work space is a science teaching lab that is equipped with central electrical outlets at the benches. This prevents power cords from becoming a safety hazard. If a teaching lab is not available, and the program must be run from the classroom, it is best to orient the desks or tables such that the power cords /extension cords are focused in one location or taped to the floor.

Academic knowledge:

- Basic understanding of photosynthesis
- Basic understanding of the ocean
- Basic understanding of terrestrial food chains/webs

What are Plankton?: An Introduction

Plankton are, by definition, any organism whose horizontal position is primarily determined by waves, currents, or tides. They are named from the Greek word for "wanderer" because they drift at the mercy of the water. There are three categories, or functional groups, of plankton. These include the phytoplankton (drifting plants), zooplankton (drifting animals), and bacteria.

Phytoplankton are an extremely important group of single-celled organisms. They are photosynthetic, so. Like other plants, they get their energy from the sun. Phytoplankton are primary producers, and form the base of the marine food web on which all other organisms feed. There are many different types of phytoplankton. Some of the most common types are diatoms, which are unique because their cell walls are composed of silica. Other types include dinoflagellates, which have whip-like tails that allow them to swim vertically through the water, and coccolithophores, which are distinguished by their calcium carbonate plates. Phytoplankton are classified not based upon their shape or structure but according to the pigments they contain and they all contain chlorophyll in tiny units called chloroplasts. Phytoplankton have evolved the most interesting ways to stay buoyant in the water, including parachute shapes to increase resistance in water, hairs or spikes to increase water drag, and air pockets in their skeletons.

Zooplankton are heterotrophic animals, meaning they get their energy from capturing and eating phytoplankton or smaller zooplankton. Zooplankton include a range of organism sizes. Some organisms spend their entire life cycle lies within the plankton, while other organisms, such as fish and crabs, spend only the larval portion of their life cycle in the plankton. Some important zooplankton include cnidarians such as jellyfish; crustaceans such as copepods and krill; chaetognaths (arrow worms); mollusks such as pteropods; and chordates such as salps and juvenile fish. Through their consumption and processing of phytoplankton (and other food sources), zooplankton play an important role in aquatic food webs, as a resource for consumers on higher trophic levels.

Suggested Reading:

Sea Soup – Zooplankton
Author: Mary M. Cerullo
ISBN: 0-88448-219-7
Publisher: Tilbury House

Sea Soup – Phytoplankton
Author: Mary M. Cerullo
ISBN: 0-88448-208-1
Publisher: Tilbury House

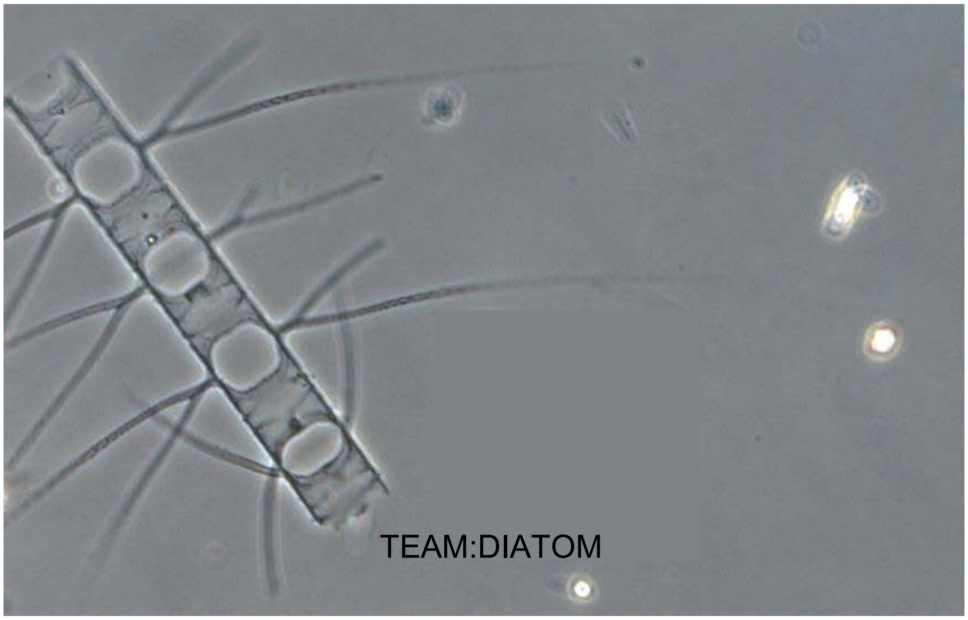
Materials

Day 1

Lecture:

- Make nametags for students and teachers (see note below)
- Powerpoint presentation (Introduction to the Ocean/Introduction to Microscopes – see Appendix IV for file download)
- Laptop computer
- Digital projector
- Utility cart

Note: Make Team nametags. Print 3” x 5” color images (e.g., diatoms, copepods, ctenophores, polychaetes, etc) onto cardstock (6 should fit on a single piece of cardstock). Cut the individual 3” x 5” card outs. Punch holes in the card and use string to make a nametag that can be worn around your neck. Distribute the tags randomly and have the students print their names on the tags with marker. Before starting a group exercise, have the students find their Teams (e.g., Team Copepod, Team Ctenophore, etc). This give the students a search image for some of the organisms they will see during the course. Team leaders, the adults that supervise the students at each microscope, can also wear a Team tag. See example.



Example nametag: Students are organized into groups, or teams, with special nametags. The images on the nametags were representative of common organisms found in local marine waters and can be a useful talking point. We laminated these nametags, wrote on them with a sharpie that can be erased, and tied string to the corners to allow us to reuse them for different class periods.

Lab

- Compound microscopes
- Dissecting microscopes
- Extension cords
- Microscope slides and coverslips (e.g., Item #632850,Carolina Biological Supply, www.carolina.com)
- Lens paper and cleaner (for teacher use, e.g., Item #634005, www.carolina.com)
- "Everyday" items to explore with the microscopes (these are suggestions):
  - Feathers
  - Bits of newspaper
  - Colored thread or yarn (a prepared slide can be purchased)
  - Hair (different types work well; a prepared slide can be purchased – e.g., www.carolina.com)
  - Insect antennae or wing
  - Flower petals, plant stems, or pollen
  - Onion skin
  - Coins
  - Fingers
  - Pencils or pens

  (Coins, Fingers, Pencils or pens: best with the dissecting microscopes)

Note: Coordinate with your local high school to borrow microscopes for use during the course.

Note: As a preparatory exercise, students could be asked to bring in items that they want to investigate with a microscope.

Day 2

Lecture:

- Nametags for students and teachers
- Powerpoint presentation (Introduction to Phytoplankton – see Appendix IV for file download)
- Laptop computer
- Digital projector
- Utility cart
- Flasks of phytoplankton with different pigmentation, some suggestions are:
  - *Tetraselmis* sp. = green
  - *Alexandrium* sp. = brown
  - *Rhodomonas* sp. = red
  - *Isochrysis* sp. = orange
- White posterboard (useful as a neutral background for flasks of phytoplankton)

Lab:

- Microscope with video camera and projector
- Compound microscopes

- Dissecting microscopes
- Extension cords
- Microscope slides and coverslips
- Lens paper and cleaner (for teacher use)
- Live phytoplankton samples, some suggestions are:
  - *Alexandrium* sp. (a large, motile dinoflagellate)
  - *Karenia brevis* (a large dinoflagellate)
  - *Chaetoceros* sp. (a large, chain-forming diatom)
  - *Coscinodiscus* sp. (a large, centric diatom)
  - *Ditylum brightwellii* (a large, pennate diatom)
- Plastic transfer pipets (e.g., Item #214551, www.carolina.com)
- Kimwipes (e.g., Item #633950, www.carolina.com)
- Plastic Petri dishes (small, e.g., Item #741246, www.carolina.com)

Note: Live phytoplankton samples can be purchased from www.carolina.com. Suggestions are: Item #151211, 151367, and 151366. The cultures range in price from $6-13.

Day 3

Art Class:

- Black construction paper (8.5 x 11)
- Colored pencils, crayons or oil pastels

Day 4

Lecture:

- Nametags for students and teachers
- Powerpoint presentation (Phytoplankton in your Home – see Appendix IV for file download)
- Laptop computer
- Digital projector
- Utility cart

Lab:

- Food and hygiene items with algae-derived ingredients (www.foodfacts.com), some suggestions are:
  - Filled cupcakes or doughnuts (e.g., Hostess, JJ's, Tastykake, Dunkin' Donuts, Entenmann's, Krispy Kreme, Little Debbie)
  - Fruit pies (e.g., Hostess, Drake's)
  - Cookies and bars (e.g., Keebler Iced Shortbread Animal Cookies, Sunbelt S'Mores Granola Treats)
  - Ice cream (e.g., Baskin-Robbins, Ben & Jerry's)
  - Chips (e.g., Doritos, Frito Lay Cheetos Crunchy Flamin' Hot Cheese Flavored Snacks)
  - Candy (e.g., Baby Ruth bars)
  - Mrs. Butterworth's syrup
  - Shampoo (e.g., Suave Naturals Ocean Breeze Shampoo infused with Sea Algae Extract and Vitamin E, Matrix Biolage Hydrating Shampoo)
  - Antacids (e.g., Tums, Gaviscon)

    - Toothpaste (e.g., Colgate)
    - Nori
    - Soy and chocolate milk (e.g., 8th Continent, Nestle, Hershey's)
    - Sour cream (e.g., Breakstone's Reduced Fat, Heluva Good Smooth 'N Creamy Light Sour Cream)
    - Pudding (e.g., Jell-O, Royal)
    - Juice (e.g., Odwalla Superfood, Bolthouse Farms Green Goodness, Naked Juice Green Machine)
- Small paper cups (for sampling juice and chocolate milk)
- Napkins
- Small muffin cups (these are useful for portioning the cupcakes)
- Plastic knife to cut the cupcakes (one quarter of a cupcake is an appropriate serving size)
- Microscope with video camera and projector
- Compound microscopes
- Dissecting microscopes
- Extension cords
- Microscope slides and coverslips
- Lens paper and cleaner (for teacher use)
- Live phytoplankton and zooplankton samples collected from the field
- Plastic transfer pipets
- Kimwipes
- Plastic Petri dishes (small)

Note: Live zooplankton samples can be purchased from www.carolina.com. Suggestions are: Item #142365 (copepods), 142314 (Daphnia), 142355 (Amphipods), and 142370 (Ostracods). Prices range from $7-8. for each culture.

Lesson Description and Procedure (Day 1)

Lecture Purpose: To provide basic information about the oceans and their importance.

Materials:

- Nametags for students and teachers
- Powerpoint presentation (Introduction to the Ocean/Introduction to Microscopes – see Appendix IV for file download information)
- Laptop computer
- Digital projector
- Utility cart

Goals:

1. Know how much of the Earth is covered with water.
2. Know several reasons why oceans are important to life on Earth
3. Know what a food web is and what a typical structure is in the ocean.

At the end of the Introduction to the Oceans presentation, the teacher or instructor will present a few slides about the use of microscopes. These will include what microscopes are and why they are used, the parts of a microscope and how to use a microscope.

Lab Purpose: To provide introductory information and experience on the use of a compound and dissecting microscope.

Materials:

- Compound microscopes
- Dissecting microscopes
- Extension cords
- Microscope slides and coverslips (e.g., Item #632850,Carolina Biological Supply, www.carolina.com)
- Lens paper and cleaner (for teacher use, e.g., Item #634005, www.carolina.com)
- "Everyday" items to explore with the microscopes (these are suggestions):
  - Feathers
  - Bits of newspaper
  - Colored thread or yarn (a prepared slide can be purchased)
  - Hair (different types work well; a prepared slide can be purchased – e.g., www.carolina.com)
  - Insect antennae or wing
  - Flower petals, plant stems, or pollen
  - Onion skin
  - Coins, pens etc. } best with the dissecting microscopes

Goals:

1. Understand how a microscope works.
2. Operate a compound and dissecting microscope.
3. Examine different items under the two types of microscope.

Students will be separated into groups of, ideally, no more than 4 to a microscope and given the nametag which denotes their team. Students will be supplied with a "microscope kit" containing a variety of different things to investigate (see materials list for suggestions). Each student will practice focusing the microscopes and looking at items under different magnifications. It is helpful to have an adult supervising and assisting each group.

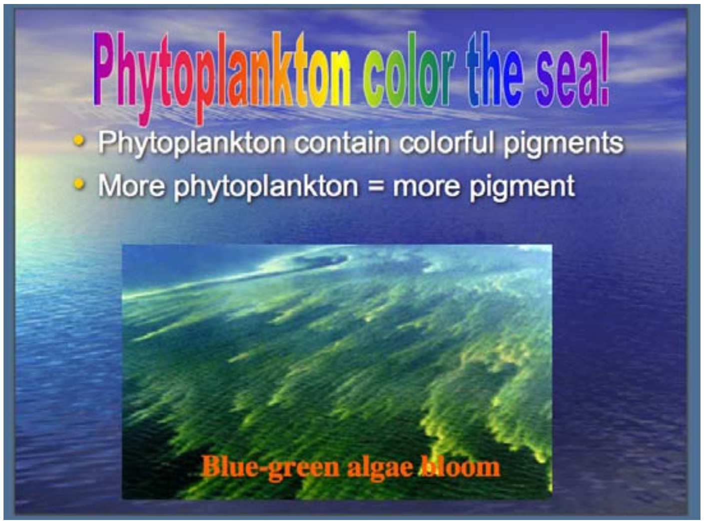
Lesson Description and Procedure (Day 2)

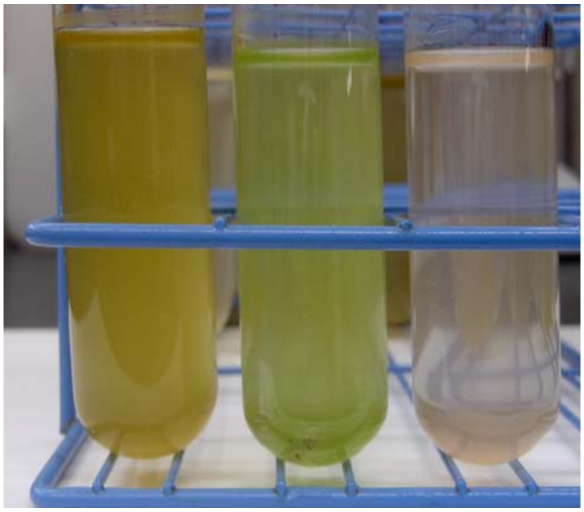
Lecture Purpose: To provide students with a basic understanding of phytoplankton, including a discussion of some of the different types, their abundance in the ocean, and their form and function.

Lecture:

- Nametags for students and teachers
- Powerpoint presentation (Introduction to Phytoplankton – see Appendix IV for file download)
- Laptop computer
- Digital projector
- Utility cart
- Flasks of phytoplankton with different pigmentation, some suggestions are:
    - *Tetraselmis* sp. = green
    - *Alexandrium* sp. = brown
    - *Rhodomonas* sp. = red
    - *Isochrysis* sp. = orange
    - White posterboard (useful as a neutral background for flasks of phytoplankton)

As you go through the lecture you can hold up different colored phytoplankton to illustrate your points and ask them questions where possible.





An example slide (left) for the powerpoint file and cultures (right) for examples of pigmentation (right). Show from left to right are *Isochrysis*, *Tetraselmis*, and *Rhodomonas*

Goals:

1. Know what phytoplankton are and understand why they are important.
2. Learn about some of the different kinds of phytoplankton and their abundance.
3. Understand the importance of different phytoplankton shapes, sizes and colors.

Lab Purpose: To allow students to examine prepared and live phytoplankton samples. Students will be expected to keep a notebook of the different organisms they look at under the microscope and to pay particular attention to their various shapes and sizes.

Materials:

- Microscope with video camera and projector
- Compound microscopes
- Dissecting microscopes
- Extension cords
- Microscope slides and coverslips
- Lens paper and cleaner (for teacher use)
- Live phytoplankton samples, some suggestions are:
    - *Alexandrium* sp. (a large, motile dinoflagellate)
    - *Karenia brevis* (a large dinoflagellate)
    - *Chaetoceros* sp. (a large, chain-forming diatom)
    - *Coscinodiscus* sp. (a large, centric diatom)
    - *Ditylum brightwellii* (a large, pennate diatom)
- Plastic transfer pipets (e.g., Item #214551, www.carolina.com)
- Kimwipes (e.g., Item #633950, www.carolina.com)
- Plastic Petri dishes (small, e.g., Item #741246, www.carolina.com)

Goals:

1. Operate a compound and dissecting microscope.
2. Examine prepared and live phytoplankton samples under different magnifications.
3. Draw the organisms observed in a notebook.

Students will be separated into groups of, ideally, no more than 4 to a microscope. Students will be supplied with a “microscope kit” containing Petri dishes, transfer pipets, and prepared phytoplankton slides. Each student will look at the prepared phytoplankton slides and try to identify whether it is a diatom or dinoflagelllate. Students will record what they observe under the microscope in their notebooks. The instructor(s) will then provide several small samples of live phytoplankton cultures to each group. Students should transfer a small amount to a Petri dish or prepare a slide of the sample, and observe it under a compound or dissecting microscope. Students should be encouraged to look at the specimen under different magnifications and record what they see under the microscope in a notebook. The instructor(s) will help students to focus their microscopes. See examples of set up below.

Small groups gather around an instructor to learn how to use the microscopes.

Two students prepare their own slides with live phytoplankton samples.

Lesson Description and Procedure (Day 3)

Art Class Purpose: To provide students with a creative exercise for synthesizing and reinforcing what had been presented in lecture and in lab, and also engaging students with different learning styles.

Materials:

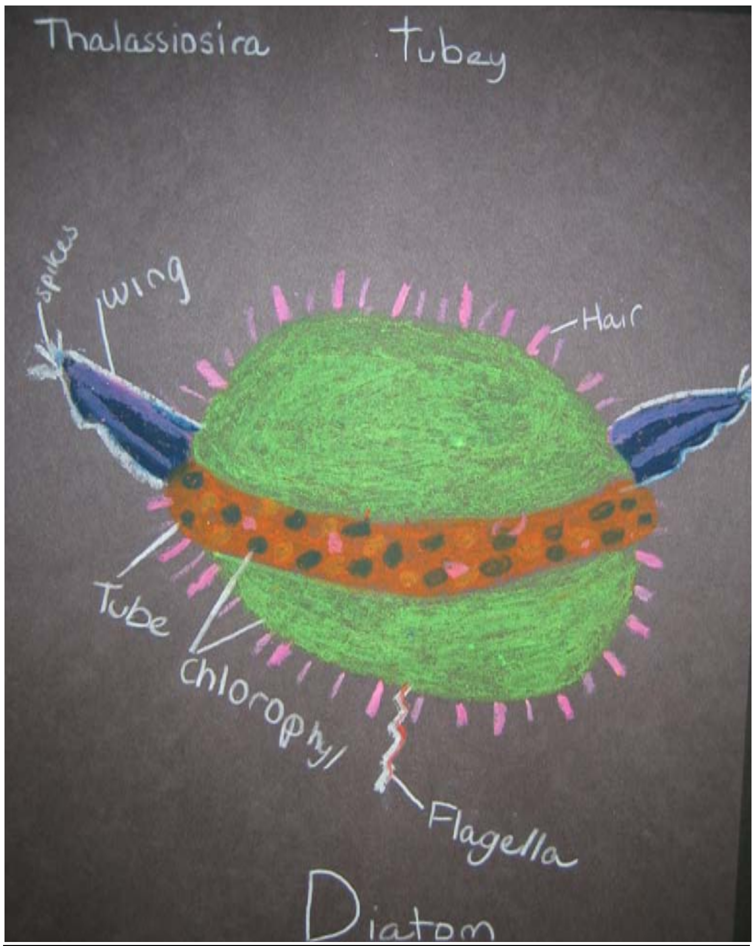
- Black construction paper (8.5 x 11)
- Colored pencils, crayons or oil pastels

Goals:

1. Develop ideas for the work by synthesizing the information and making preliminary sketches.
2. Create a 2D representational artwork from direct observations and imagination.
3. Label the adaptations given to the "new" organism for its survival.
4. Provide a scientific name (genus and species) for the "new" organism.
5. Be able to explain the utility of the adaptations, either through a creative writing exercise or through a short presentation to the class.

Students create their own unique phytoplankton species, complete with creative adaptations, such as propellers, solar panels, and life vests, which they thought would help it survive in the water.

Students will be asked to design/invent their own phytoplankton, giving it creative adaptations for survival in the ocean. The art teacher or instructor should create an example before the class begins. Some examples of creative adaptations that students have given their phytoplankton in the past are: water wings, bubbles, inner tubes, spines, spikes, solar panels. Show your own example and explain the process to the class. Oil pastels, colored pencils and crayons provide a vivid image on black construction paper. The paper should be no larger than 8.5 x 11. If the paper is too large, the project will exceed a typical 45-60 minute class period. Students can be separated into groups of 4 or 5. This is useful for encouraging discussion of ideas, although students should be encouraged to come up with their own designs. The students will draw their new creature with its adaptations and should be able to describe why those adaptations are useful to its survival. For example, a student might say that their species needs an inner tube to help it float high in the water, close to the sunlight it uses for photosynthesis. See example below.



An imaginary, student-designed phytoplankton species , replete with scientific name and labeled adaptations (oil pastels on black construction paper).

Lesson Description and Procedure (Day 4)

Lecture Purpose: To present and describe the many uses for phytoplankton and their derivatives and encourage an appreciation for how common these ingredients are in our everyday lives.

Materials:

- Nametags for students and teachers
- Powerpoint presentation (Phytoplankton in your Home – see Appendix IV for file download)
- Laptop computer
- Digital projector
- Utility cart
- Food and hygiene items with algae-derived ingredients (www.foodfacts.com), some suggestions are:
  - Filled cupcakes or doughnuts (e.g., Hostess, JJ's, Tastykake, Dunkin' Donuts, Entenmann's, Krispy Kreme, Little Debbie)
  - Fruit pies (e.g., Hostess, Drake's)
  - Cookies and bars (e.g., Keebler Iced Shortbread Animal Cookies, Sunbelt S'Mores Granola Treats)
  - Ice cream (e.g., Baskin-Robbins, Ben & Jerry's)
  - Chips (e.g., Doritos, Frito Lay Cheetos Crunchy Flamin' Hot Cheese Flavored Snacks)
  - Candy (e.g., Baby Ruth bars)
  - Mrs. Butterworth's syrup
  - Shampoo (e.g., Suave Naturals Ocean Breeze Shampoo infused with Sea Algae Extract and Vitamin E, Matrix Biolage Hydrating Shampoo)
  - Antacids (e.g., Tums, Gaviscon)
  - Toothpaste (e.g., Colgate)
  - Nori
  - Soy and chocolate milk (e.g., 8th Continent, Nestle, Hershey's)
  - Sour cream (e.g., Breakstone's Reduced Fat, Heluva Good Smooth 'N Creamy Light Sour Cream)
  - Pudding (e.g., Jell-O, Royal)
  - Juice (e.g., Odwalla Superfood, Bolthouse Farms Green Goodness, Naked Juice Green Machine)
- Small paper cups (for sampling juice and chocolate milk)
- Napkins
- Small muffin cups (these are useful for portioning the cupcakes)
- Plastic knife to cut the cupcakes (one quarter of a cupcake is an appropriate serving size)

Goals:

1. Learn that phytoplankton (microalgae) and seaweeds (macroalgae) are used by humans in many ways.

2. Taste some of the most common food items that contain algae or algal derivatives.

Select several food and non-food items that contain algae or algae derivatives to bring to class. Show these items to the students, without mentioning that they come at least partially from the ocean. Ask the students to guess what the items might have in common. The teacher or instructor may then discuss the many uses for algae and their derivatives or present a few slides on the topic. Students will be given the opportunity to taste small portions of several of the food items containing algae or algae-derivatives.

Lab Purpose: To allow students to examine live phytoplankton and zooplankton samples from a local water sample. Students will be expected to use their knowledge of phytoplankton shapes and sizes to help them discern zooplankton from phytoplankton.

Materials:

- Microscope with video camera and projector
- Compound microscopes
- Dissecting microscopes
- Extension cords
- Microscope slides and coverslips
- Lens paper and cleaner (for teacher use)
- Live phytoplankton and zooplankton samples collected from the field
- Plastic transfer pipets
- Kimwipes
- Plastic Petri dishes (small)

Goals:

1. Operate a compound and dissecting microscope.
2. Examine phytoplankton and zooplankton from a local water sample under different magnifications.
3. Appreciate the diversity of microscopic organisms present in the student's local waters.

Students find something interesting in a seawater sample.

Students will be separated into groups of, ideally, no more than 4 to a microscope. Students will be supplied with a "microscope kit" containing Petri dishes, transfer pipets, and a small beaker containing a few milliliters of water sample. Students should transfer a small amount to a Petri dish or prepare a slide of the sample, and observe it under a compound or dissecting microscope. Students should be encouraged to look at the specimen under different magnifications. Students should also be encouraged to try to identify different types of phytoplankton (e.g., diatoms and dinoflagellates) and try to discern the difference between phytoplankton and zooplankton. The instructor(s) will help students to focus their microscopes and the instructor(s) should be prepared to help students identify the organisms present in their water sample.

Timeline

The timeline indicates approximate time allocations for each component for each day. While these times are flexible, it is best to keep things dynamic and moving at a pace that keeps students' interest piqued. The hands-on laboratory component should be given sufficient time such that all students get ample time to use the microscopes.

Day	Lecture	Laboratory
1	15-20 min.	20-25 min.
2	15 min.	≥30 min.
3 (ART)		45-60 min.
4	25 min.	25 min.

Note: On day 1, allow some extra time for introducing yourself to the class, explaining why you are there and providing an overview of the week ahead.

Assessments

The assessments for the AOP are multi-tiered. First, the teacher you work with may want to incorporate his or her own assessments into the program to determine successful completion of the project. He or she should come up with a scoring tool, or rubric, that lists the criteria for a piece of work and will help define the quality of that work. The researcher should work with the teacher to develop this rubric prior to the Program visit. The second tier of the AOP assessments involve evaluating the program itself and determining what its successes and failures were from both the teacher and student perspectives. To aid this process, ask that the participating teachers and students respond to the following brief surveys. Depending on your needs you make want to seek help from a professional evaluator.

Teacher Survey: This survey is meant to assess your experience with the Artistic Oceanographer program. It is also meant to provide us with suggestions and comments on how we might improve the quality of our program. Please answer the questions as accurately as possible and include as much information as you can.

1. How did you find out about this program?

2. Did you find the activities and content presented as part of the Artistic Oceanographer program appropriate for your students?

Age: Were the activities and content appropriate for 5th graders? Please describe.

Focus: Was too much/too little time spent on any topic or activity? Please describe.

Curriculum Standards: Do you think the goals of the program were well aligned with current state science and art standards? Did this program augment your curriculum? Please describe.

3. What were the most valuable/successful elements of the program? Less valuable/successful?

4. For the most useful activities, why did you find these especially effective?

5. What do you think are the benefits to having scientists present this material to your students? What are the drawbacks?

6. Would you run this program on your own, without outside assistance? If no, what would prevent this program from being continued?

Student Survey: Please answer the following questions about the Artistic Oceanographer program that you just completed.

1. What did you like about having scientists come visit your classroom?

2. What did you learn about the oceans?

3. What did you learn about phytoplankton?

4. What was your favorite part about the program?

Enrichments

The following topics, ordered by subject, are suggestions for teachers to build on student interest in ocean and aquatic sciences generated during the AOP and integrate these topics into existing curricula.

Math:

- Units of the metric system
- Conversions (e.g., converting the depth of the ocean in meters to miles or a unit that would resonate with 5th graders)
- Basic math (e.g., calculating how much food would be necessary at the base of the food web to support a large organism such as a Killer whale)

Music:

- Sounds in and associated with the ocean (e.g., marine mammal communication, waves crashing or slapping against the beach)

Language Arts:

- Creative writing (e.g., write a paragraph or story about the new phytoplankton that was created in the art class)
- Poetry (e.g., haiku based on ocean sounds: http://artsedge.kennedy-center.org/content/2080/)
- Vocabulary (e.g., introduce science-related words like phytoplankton, zooplankton, and food web into a vocabulary lesson, discuss how ocean related words have permeated our language: http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/education_lesson2.html)
- Reading (e.g., assign a book to the class, a good source for ocean-related books is: http://www.geocities.com/Athens/Atrium/5924/storybooksaboutmarinelife.htm http://www.carolhurst.com/subjects/oceans.html)

History:

- Ocean exploration (e.g., past and present, from diving bells to robots)
- Navigation (e.g., use of the oceans by immigrants and explorers, such as the Pilgrims, Christopher Columbus, and Charles Darwin)
- Cultures (e.g., use of the oceans for food and resources, ocean travel, recreation)
- Microscopy (e.g., their invention and role in evolving medicine)

Science:

- Optics (e.g., use the light microscopes to introduce properties and behavior of light)
- Properties of water
- Properties of sound (e.g., using sound to determine ocean depth)
- Climate and the water cycle

Human vision and eye physiology (e.g., use the light microscopes to teach how humans see)

Acknowledgements

The Artistic Oceanographer program was developed under a Woods Hole Science and Technology Education Partnership (WHSTEP) grant and has continued with the support of an EPA/ECOHAB Grant (#RD83322201) and a Falmouth Education Foundation (FEF) grant. The handbook for the program was funded by a C-MORE Education grant. We would like to thank the participating science and art teachers, Patricia Keoughan and Aimee Maseda, from Morse Pond School. We would also like to thank Christine Brothers from Falmouth High School for allowing us to borrow compound microscopes. We are grateful for the help provided by Andrew Juhl (LDEO) and Louie Wurch (WHOI) in teaching portions of the course. And, we appreciate the help of our volunteers: Liz Orchard, Katie Libera, Whitney Krey, Erin Bertrand (WHOI).

Appendix I: Materials Checklist

Day 1

- __Nametags for students and teachers
- __Powerpoint presentation (Introduction to oceans)
- __Laptop computer
- __Digital projector
- __Utility cart
- __Compound microscopes
- __Dissecting microscopes
- __Extension cords
- __Microscope slides and coverslips
- __Lens paper and cleaner (for teacher use)
- __ "Everyday" items to explore with the microscopes

Day 2

- __Nametags for students and teachers
- __Powerpoint presentation (Introduction to phytoplankton)
- __Laptop computer
- __Digital projector
- __Utility cart
- __Flasks of phytoplankton with different pigmentation
- __White posterboard (useful as a neutral background for flasks of phytoplankton)
- __Microscope with video camera and projector
- __Compound microscopes
- __Dissecting microscopes
- __Extension cords
- __Microscope slides and coverslips
- __Lens paper and cleaner (for teacher use)
- __Live phytoplankton samples, some suggestions are:
- __Plastic transfer pipets
- __Kimwipes (2 boxes)
- __Plastic Petri dishes (small)

Day 3

- __Black construction paper (8.5 x 11)
- __Colored pencils, crayons or oil pastels

Day 4

- __Nametags for students and teachers
- __Powerpoint presentation (Phytoplankton in your Home)
- __Laptop computer
- __Digital projector
- __Utility cart
- __Food and hygiene items with algae-derived ingredients (www.foodfacts.com)
- __Small paper cups (for sampling juice and chocolate milk)

__Napkins
__Small muffin cups (these are useful for portioning the cupcakes)
__Plastic knife to cut the cupcakes
__Microscope with video camera and projector
__Compound microscopes
__Dissecting microscopes
__Extension cords
__Microscope slides and coverslips
__Lens paper and cleaner (for teacher use)
__Live phytoplankton and zooplankton samples collected from the field
__Plastic transfer pipets
__Kimwipes
__Plastic Petri dishes (small)

Appendix II: Grade Five Curriculum Standards for C-MORE States

California – source: California State Board of Education (http://www.cde.ca.gov/be/st/ss/scgrade5.asp)

I. Science Standards
   A. Life Sciences
      1. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:
         a. Students know plants use carbon dioxide (CO_2) and energy from sunlight to build molecules of sugar and release oxygen.
         b. Students know plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO_2) and water (respiration).
   B. Earth Sciences
      1. Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept:
         a. Students know most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.
   C. Investigation and Experimentation
      1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
         a. Classify objects in accordance with appropriate criteria.
         b. Plan and conduct a simple investigation based on a student-developed question and write instructions others can follow to carry out the procedure.
         c. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.
         d. Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.

II. Visual and Performing Arts Standards
   A. Artistic Perception
      1. Processing, analyzing, and responding to sensory information through the language and skills unique to the visual arts
         a. Students perceive and respond to works of art, objects in nature, events, and the environment. They also use the vocabulary of the visual arts to express their observations.
   B. Analyze Art Elements and Principles of Design
      1. Use their knowledge of all the elements of art to describe similarities and differences in works of art and in the environment.
   C. Creative Expression
      1. Creating, performing, and participating in the visual arts

a. Students apply artistic processes and skills, using a variety of media to communicate meaning and intent in original works of art.

D. Communication and Expression Through Original Works of Art
  1. Create an expressive abstract composition based on real objects.
  2. Communicate values, opinions, or personal insights through an original work of art.

Hawai'i – source: Hawai'i Department of Education Content and Performance Standards (http://www.hcps.k12.hi.us/)

I. Science Standards
  A. Doing Scientific Inquiry
    1. Students demonstrate the skills necessary to engage in scientific inquiry.
      a. Design and conduct simple investigations to answer their questions or to test their ideas about the environment.
      b. Collect and organize data for analysis, using simple tools and equipment.
  B. Using Unifying Concepts And Themes
    1. Students use concepts and themes such as system, change, scale, and model to help them understand and explain the natural world.
      a. System: observe and describe how parts influence one another in a system.
      b. Scale: measure things that are difficult to measure because they are very large or very small (e.g., buildings, trees, seeds, pinhead).
      c. Model: use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, or stories to represent corresponding features of objects, events, and processes in the real world. Identify ways in which the representations do not match their original counterparts.
  C. Cycle Of Matter And Energy Flow
    1. Students trace the cycling of matter and the flow of energy through systems of living things.
      a. Diagram how animals' food can be traced back to plants.

II. Visual and Performing Arts Standards
  A. Students understand and apply art materials, techniques, and processes in creating original artworks based on ideas, experiences, stories, and opinions.
  B. Select and apply materials, techniques, and processes to communicate ideas about self and the environment; and reflect upon effectiveness of choices.
  C. Apply materials, techniques, and processes in various ways to evoke different responses.

  D. Students identify, understand, and apply the elements and principles of art using the language of the visual arts. The elements of art are: line, shape, form, space, value, texture, color, time, and motion. The principles of art are: emphasis, balance, proportion, pattern, repetition & variation, transition, rhythm, and unity.

1. Identify and apply the twelve basic colors.
2. Demonstrate fluency in applying multiple combinations of elements and principles in creating works of art.
3. Use the vocabulary of the elements and principles in describing and analyzing own work, the works of others, and the environment.
4. Apply various elements and principles to create depth, volume, and mass in creating artworks.
5. Identify, apply, and incorporate the principles of repetition & variation; rhythm, unity, time, and motion through vocabulary usage and in artworks.
6. Recognize and describe the principles of repetition & variation; rhythm, and unity in the environment and in the works of others.

Oregon – source: Oregon Department of Education (http://www.ode.state.or.us/teachlearn/real/)

I. Science Standards
   A. Life Science
      1. Organisms: Understand the characteristics, structure, and functions of organisms.
         a. Group or classify organisms based on a variety of characteristics.
         b. Classify a variety of living things into groups using various characteristics.
         c. Describe basic plant and animal structures and their functions.
         d. Associate specific structures with their functions in the survival of the organism.
      2. Diversity/Interdependence: Understand the relationships among living things and between living things and their environments.
         a. Describe the relationship between characteristics of specific habitats and the organisms that live there.
         b. Use drawings or models to represent a series of food chains for specific habitats.
         c. Identify the producers, consumers, and decomposers in a given habitat.
         d. Recognize how all animals depend upon plants whether or not they eat the plants directly.
         e. Describe how adaptations help a species survive.

   B. Scientific Inquiry
      1. Forming the Question/Hypothesis: Formulate and express scientific questions or hypotheses to be investigated.
      a. Make observations. Ask questions or form hypotheses based on those observations, which can be explored through scientific investigations.

2. Collecting and Presenting Data: Conduct procedures to collect, organize, and display scientific data.
    a. Collect, organize, and summarize data from investigations.

II. Visual and Performing Arts Standards
  A. Create, Present, and Perform
    1. Use experiences, imagination, observations, essential elements and organizational principles to achieve a desired effect when creating, presenting and/or performing works of art.
    2. Apply the use of ideas, techniques and problem solving to the creative process and analyze the influence that choices have on the result.
        a. Identify the creative process used, and the choices made, when combining ideas, techniques and problem solving to produce one's work.
    3. Express ideas, moods and feelings through the arts and evaluate how well a work of art expresses one's intent.
        a. Create, present and/or perform a work of art and explain how the use of essential elements and organizational principles shapes an idea, mood or feeling found in the work.
    4. Evaluate one's own work, orally and in writing.
        a. Critique one's own work using self-selected criteria that reveal knowledge of the arts, orally and in writing.

Massachusetts – source: Massachusetts Department of Education (http://www.doe.mass.edu/frameworks/current.html)

I. Science Standards
  A. Life Science and Biology
    1. Adaptations of Living Things
        a. Describe how organisms meet some of their needs in an environment by using behaviors in response to information received from the environment.
    2. Energy and Living Things
        a. Describe how energy derived from the sun is used by plants to produce sugars (photosynthesis) and is transferred within a food chain from producers (plants) to consumers to decomposers.

II. Visual and Performing Arts Standards
  A. Methods, Materials, and Techniques
    1. Use a variety of materials and media, for example, crayons, chalk, paint, clay, various kinds of papers, textiles, and yarns, and understand how to use them to produce different visual effects
    2. Create artwork in a variety of two-dimensional (2D) and three-dimensional (3D) media, for example: 2D – drawing, painting, collage, printmaking,

weaving; 3D – plastic (malleable) materials such as clay and paper, wood, or found objects for assemblage and construction

3. Learn and use appropriate vocabulary related to methods, materials, and techniques
4. Learn to take care of materials and tools and to use them safely

B. Elements and Principles of Design
   1. Identify primary and secondary colors and gradations of black, white and gray in the environment and artwork
   2. Explore the use of line in 2D and 3D works
   3. Explore the use of shapes and forms in 2D and 3D works
   4. Explore the use of patterns and symmetrical shapes in 2D and 3D works
   5. Explore composition by creating artwork with a center of interest, repetition, and/or balance

C. Observation, Abstraction, Invention, and Expression
   1. Create 2D and 3D expressive artwork that explores abstraction
   2. Create 2D and 3D artwork from memory or imagination to tell a story or embody an idea or fantasy

Appendix III: Classroom Visit Planning Sheet

Teacher:______________________________
School name:__________________________
School phone:_________________________
Email:_________________________________
Grade level:____________________
Length of class period:_________________

Principal:__________________________
Address:____________________________
Home phone:_______________________
Number of students:__________________

Special circumstances:

Science the students are doing:

Topic(s) I may talk about:

What students already know about these topics:

Questions students may have about these topics:

Teacher's goals for the visit:

Important student skills in math, maps, graphs, etc.:

Equipment I may need to ask about:

Access to the school:
- Where we will meet:
- Time we will meet:
- Check in at office?
- Special conditions?

Appendix IV: PowerPoint Presentations

Presentations used for the AOP may be downloaded on the following website:

http://www.whoi.edu/sbl/liteSite.do?litesiteid=6692&articleId=10031

Appendix V: Additional Information

Contact information:

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Online Resources:

A virtual world with marine science education activities:
www.whyville.net

Deep sea education expeditions:
www.divediscover.whoi.edu

A curriculum repository:
http://www.dlese.org/library/index.jsp

Resources in oceanography education:
www.kidsolr.com/science/page15.html
http://cmore.soest.hawaii.edu/
http://www.mbayaq.org/lc/teachers_place/
http://oceanexplorer.noaa.gov/
http://necosee.net/