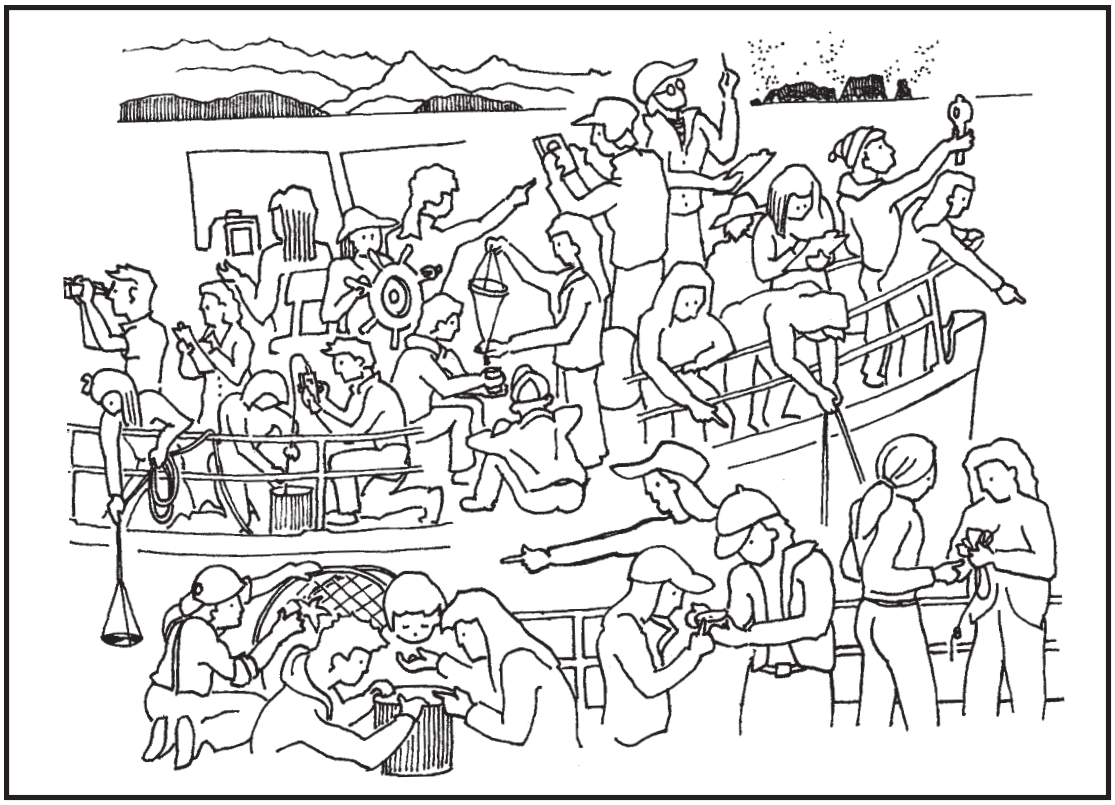
Kachemak Bay Onboard Oceanography Program Teacher Manual



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The Kachemak Bay Onboard Oceanography Program has been developed and provided by a dedicated group of volunteers and staff. Jane Middleton developed a secondary curriculum in 1994, with funding provided by EPA. Kathy Herrnsteen revised the curriculum and program for the upper elementary level. The program would not be possible without the generosity of Jack Montgomery, Captain of the *Rainbow Connection*, and his crew members, especially Ginger Moore Strong who reviewed this Teacher Manual.

The Center for Alaskan Coastal Studies is a membership-based 501-c-3 educational nonprofit organization whose mission is to foster responsible interaction with our natural surroundings and to generate knowledge of the marine and coastal ecosystems of Kachemak Bay through environmental education and research programs.

Goals

Education: To increase awareness and understanding of coastal and marine ecosystems by providing environmental education programs and field experiences to students and the general public.

Stewardship: To be caretakers and to motivate others to be caretakers of the Alaskan coastal and marine environments.

Research: To acquire data needed for making informed decisions on the use and sustainable development of Kachemak Bay, and to facilitate research efforts by governmental, academic, and private research programs.

Kachemak Bay Onboard Oceanography Teacher Manual

Table of Contents

INTRODUCTION

Welcome to your floating classroom on Kachemak Bay. The purpose of this class excursion is to give students an applied scientific inquiry experience. Using the knowledge they obtained in the classroom and on the boat, the students will conduct a series of measurements designed to gather information to help them complete the class mission.

The students should be told, both in the classroom and on their "floating classroom" that there will be a mission, a purpose for the day.

REMEMBER -
THIS IS A SCHOOL DAY, NOT A FUN AND GAMES DAY.

CLASS MISSION

You are going to start an oyster farm in Kachemak Bay. You need to decide whether you will put the farm on the north side of the bay (the Homer side) or the south side of the bay (the Peterson Bay side) and explain the reasons for your decision.

Through the activities they will carry out on the trip, students will learn about the role of oysters in Kachemak Bay food web and gather information and several types of data upon which they can base their decision. Once back in the classroom, the class will form a conclusion and communicate their reasoning about where to place the oyster farm. They will also learn about the role of an exotic species (one that does not occur naturally) in a marine ecosystem in terms of benefits to people and relationships to naturally-occurring species.

Educational Objectives

The Kachemak Bay Onboard Oceanography program is an extended science inquiry that addresses the following Alaska State Science Content Standards (**areas of emphasis are shown in bold**):

Students will:
A-14 **Understand the interdependence of living things and their environment** (component of Interdependence)

B-1 **Use the processes of science: these processes include observing, classifying, measuring, interpreting data, inferring, communicating**, controlling variables, developing models and theories, hypothesizing, predicting, and experimenting.

B-2 Design and **conduct scientific investigations using appropriate instruments.**

Students will also have exposure to additional Alaska State Science Standards:

Students will:
A-4 **Understand observable natural events such as tides**, weather, seasons, **and moon phases in terms of the structure and motion of the earth** (Earth)

A-9 **Understand the transfers and transformations of matter and energy that link living things and their physical environment, from molecules to ecosystems** (Flow of Matter and Energy)

A-15 Use science to understand and describe the local environment (Local Knowledge)

B-6 Employ strict adherence to safety procedures in conducting scientific investigations.

D-3 Recommend solutions to everyday problems by applying scientific knowledge and skills.

Additional information on the science standards is in Appendix B.

SUMMARY OF ACTIVITIES

A GENERAL explanation of the "floating classroom" activities and how each relates to the mission.

1. MARINE WATCH - An observation activity. Group leaders will discuss how the things observed in the environment might affect the quality of the water for the growth and survival of oysters and other living things in Kachemak Bay.

2. HELM - The helm contains many pieces of equipment a boat owner would need to safely drive a boat. To collect scientific data about Kachemak Bay or to get to an oyster farm, a boat is needed and the ability to navigate. The students will learn about the equipment that could be found in the helm of a boat and how it is used.

3. PLANKTON TOW - The students will learn how to sample plankton which the oysters and many other marine organisms eat and where plankton are found. They will make plankton tows and compare the appearance of plankton samples from the north side and the south sides of the bay.

4. WATER SAMPLING - Like all living things, oysters require special conditions to survive. The temperature, pH, and salinity of the water must fall within a specific range for the oysters to survive and grow. Students will sample the water on the north and south sides of the bay and measure specific properties of water to conditions needed by oysters to survive and grow.

5. SECCHI DISK (Part A) and pH (Part B)

Part A - Water absorbs the sunlight that supports photosynthesis by phytoplankton (the plant portion of the plankton), but only to a certain depth. With sunlight, carbon dioxide, water, and plant chlorophyll, the phytoplankton can make the food which will not only be eaten by oysters, but by zooplankton and many other animals in the Kachemak Bay marine and intertidal environments. Silt and other substances make water turbid and less transparent to light, thus reducing the depth at which photosynthesis can occur. Students will use a Secchi disk to measure the transparency of the water, the depth to which sunlight does penetrate and support photosynthesis, and determine a turbidity depth on both the north and south sides of the bay. This depth will be used to determine the depth for making the plankton tows.

Part B - Living things can survive only within a certain range of acidity or alkalinity of water, which varies in a bay depending on fresh and salt water movements and mixing. Students will measure this condition by testing and comparing the pH of the water on the north and south sides of the bay. They will also test the pH of several other liquids.

6. CHARTS (Part A), CURRENTS (Part B) AND TIDES (Part C).

Part A - The students will review what the tides are and how they occur. They will learn to read a tide chart for Kachemak Bay and discuss the implications of a large tidal range on conditions for living things and on siting an oyster farm.

PART B - The nautical charts of Kachemak Bay contain information that will help the students compare physical aspects of the environment on the north and south sides of the bay that would affect the success of an oyster farm. Students will use nautical charts to compare water depths, bottom conditions (muddy, silty, etc.), locations of outlets from glaciers, rivers, and streams on the north and south side of the bay and compare conditions for oyster farming. They will also learn or review the determination of latitude and longitude.

PART C - The circulation pattern in Kachemak Bay is complex because of ocean currents, tides, freshwater currents, and the influence of the Homer Spit. Students will observe a chart of the surface current patterns and discuss how salt and fresh water moves in the bay during tidal cycles and different seasons. They will also discuss the effects of these patterns on the distribution of nutrients, plankton (oyster food), and water of different salinities in the bay.
These activities will culminate in a hypothesis about the relative success of oyster farms on the north or south side of the bay.

7. GULL ISLAND - Gull Island is a seabird rookery in Kachemak Bay. The long-term presence of large numbers of seabirds in Kachemak Bay is an indication of the rich and diverse food web in the bay. Their "guano" produces a tremendous amount of nitrogen needed by the plankton for photosynthesis. Students will observe and identify the birds of Gull Island and discuss their role in the Kachemak Bay food web. (Optional trip, weather - dependent)

8. OYSTER FARM VISITATION (MARICULTURE) - Students will visit an oyster farm in Kachemak Bay. The oyster farmer will tell the students about commercial oyster farming in Kachemak Bay and answer questions. He/she will show and tell the students things like: a) what an oyster looks like, b) examples of oysters at different ages, c) the special trays and lantern baskets the oysters are raised in, d) what types of things in Kachemak Bay harm the oysters (bird and invertebrate predators, pollution - silt and bacteria from human waste, "red tide" plankton blooms, etc.).

9. MICROSCOPE - The students will use microscopes to observe plankton (microscopic plants and animals) in their plankton tow samples from both the north and the south side of Kachemak Bay to determine whether there is food available for their oysters in each location. They will compare the types and relative abundance of plankton in the north and south samples and at different depths and learn about the role of individual species in the Kachemak Bay food web.

10. CRAB POTS - The students will participate in collecting data on the crab populations in Kachemak Bay and learn that these populations can change dramatically in just a few years. After an explanation of what crab pots are, and how they fish for crab, the students will watch as a crab pot is "dropped". When the pots are pulled, students will participate in identifying the species, determining the sex and measuring each crab. They will also observe other organisms that may be captured in the crab pots and discuss the role of each in the Kacheamk Bay food web and any relationship they might have with oysters.

ONBOARD OCEANOGRAPHY ACTIVITIES

ACTIVITY: #1 Marine Watch

SUMMARY OF THE ACTIVITY:

As the boat is leaving its slip in the harbor, the students, in their groups with a chaperone and a volunteer, will begin watching the water, the air and the land for specific "things" on a bingo card. The volunteer will discuss the things that could affect the water quality. Each group will be assigned a specific location on the deck of the boat from which to do their "watching." As the students in a group see an item, they are to mark it with an X on the groups OCEAN BINGO card. The volunteer will help the students locate "things," and help them discuss how those "things" could affect the quality of the water the plankton (oyster food) and the oysters live in.

The first block of time on the boat will be officially devoted to this activity. The stop at Gull Island will continue the activity. The students, however, should continue to fill out the OCEAN card throughout the day, with the aid of their chaperone, when they are not involved in another activity.

HOW ACTIVITY RELATES TO THE MISSION:

Oysters, like the plankton they eat and all living things in the water, need clean water - water that is free or has very low levels of substances that are harmful or toxic to life. In addition, because oysters are filter-feeders that can concentrate substances or plankton in their body, oyster farms can't be sited in areas where they would concentrate substances that are harmful to people. Since students will be deciding whether to put their oyster farm on the north side or on the south side of Kachemak Bay, water quality is an important determining factor! On the way to their sampling location on the north side of the bay, the students will look for things in the environment in this activity that could affect the quality of the water**.** The students will also discuss how these things could affect the quality of the water. Examples of things the students will be looking for are: drainage from forest products, specific types of boats, floating debris, and erosion. They will also observing marine mammals, sea birds, glaciers, navigational aids and buoys, and volcanoes.

ACTIVITY #2: Helm Station

SUMMARY OF THE ACTIVITY:

The students will be shown the basic equipment a small boat or skiff should have to operate safely and to navigate. The students will also learn why the equipment is important and how to use it.

Helm equipment:

a. depth finder
b. radio
c. compass
d. GPS
e. Kachemak Bay chart
f. Loran
g. radar

HOW ACTIVITY RELATES TO THE MISSION:

The helm contains many pieces of equipment a boat owner needs to drive a boat safely. To get to their oyster farm and to collect scientific data about Kachemak Bay, the students will need a small boat. The volunteer will use the helm of this large boat to describe, explain and show the students the basic equipment they would probably have and use for navigation.

ACTIVITY #3: Plankton Station - Sampling with a Plankton Tow

SUMMARY OF THE ACTIVITY

The group of students will assist the deckhand and/or volunteer in collecting several samples of water from various depths (maximum depth determined by the Secchi disk) using a commercial plankton tow and a student-made tow if available.

HOW ACTIVITY RELATES TO THE MISSION:

The students will need to know if there is plankton (oyster food) available in the area they decide to start their oyster farm. The plankton tow will provide them with a sample of the water from both sides of the bay to study under the microscope.

ACTIVITY #4: WATER SAMPLING STATION

SUMMARY OF THE ACTIVITY:

The students will take a sample of the water at a depth of 5 meters on both the north side and the south side of Kachemak Bay. Using a thermometer, they will determine the temperature of the air and of their water sample. Using a "sea tester," a simple hydrometer, they will measure salinity indirectly by determining the density of their water sample. They will then convert their density to a standard temperature of 15 degrees Centigrade, using a correction table. They will also use a conversion table to convert the standardized density reading to salinity in terms of parts per thousand.

HOW ACTIVITY RELATES TO THE MISSION:

Like all living things, oysters and the plankton they eat can only survive and grow under certain conditions of temperature and salinity (salt concentration) The data sheet includes information on the range preferred by oysters for comparison with conditions that the students measure.

SALINITY
WORK SHEET

Study the diagrams below. Then read each statement and decide whether it is TRUE or FALSE.

1. In diagram 1, area A would be saltier than area B.

2. In diagram 1, area B would be saltier than area C.

3. In diagram 2, area D would have more water evaporating form it than area E.

4. Evaporation makes salt water saltier.

5. Rain dilutes salt water making it less salty.

6. The water temperature just below the surface of Kachemak Bay would be lower on a sunny day than on a rainy day.

7. The large amount of sunlight shining on Kachemak Bay in the winter, makes the water near the surface of Kachemak Bay warmer in the winter than in the summer.

ACTIVITY NAME #5: Secchi disk and pH

PART A: SECCHI DISK

SUMMARY OF THE ACTIVITY:
Students will lower a specially-marked disk, the Secchi disk, on a rope into the water until it disappears from view. Using marked distances on the rope, they will then calculate the water depth at which this occurred, subtracting the distance from the boat rail to the surface of the water. This depth is a measurement of the transparency of the water relative to human sight, also called the turbidity depth measurement. They will then read a chart that relates this depth to the depth at which phytoplankton no longer receive enough light for photosynthesis. This lower depth will be used to determine the maximum depth to make plankton tows.

HOW THE ACTIVITY RELATES TO THE MISSION:
The turbidity measurement is important for siting an oyster farm because it tells how deep into the water sunlight can penetrate and thus, how deep oysters can be placed and feed on plankton. Sunlight is needed by the phytoplankton, the plant portion of plankton, to make food via photosynthesis. With sunlight, carbon dioxide, clean water and chlorophyll available, the phytoplankton make their own food which will be eaten not only by oysters, but by the zooplankton which the osyters also eat. Students will be able to compare the turbidity measurements on the north and south sides of the bay.

PART B: pH Activity

SUMMARY OF ACTIVITY:
The students will test 8 unknown liquids with pH paper to determine 1) whether each unknown is an acid or a base, and 2) how acidic or alkaline each unknown liquid is. The unknown liquids will include the water samples from either the north side or the south side of Kachemak Bay.

HOW ACTIVITY RELATES TO THE MISSION:
Like all living things, oysters can only survive within a certain range of acidity or alkalinity. Strongly acidic and stongly basic waters are harmful or toxic to most living things. The pH data from the Kachemak Bay water sample will be used by the students back in the classroom to compare with the pH range preferred by oysters. The waters oysters live in must be within a particular pH range.

ACTIVITY #6: Tides, Charts, and Water Circulation Patterns

SUMMARY OF ACTIVITY: PART A - TIDES

The volunteer and the students will study the Seldovia tide book for the current month. The volunteer will point out the two high tide and low tide columns and review what tides are, their causes and the relationship between the tides and the changes in the moon. The students will use the Seldovia tide page to answer a series of questions regarding tides in Kachemak Bay. The volunteer will also discuss with the students the implications of the large tidal range in Kachemak Bay and the importance of knowing how to read a tide book, especially if you are a beach walker, a boater and/or an oyster farmer.

SUMMARY OF ACTIVITY: PART B - CHARTS

In the "Chart" activity, the volunteer will help the students study the large nautical chart of Kachemak Bay. He/she will show the students how to read the chart for information that would influence conditions for living things in the bay and thus, the choice of an oyster farm site like water depth, bottom conditions (muddy, silty, etc.), locations of glaciers, rivers and streams. Students will also review or learn how to read other information helpful for navigating on nautical charts - latitude and longitude, nautical miles, land formations (islands, Homer Spit, etc.), navigational aids, etc. While the volunteer is working with the students they will 1) draw where they went today on their small charts, 2) using the Kachemak Bay nautical chart, determine the latitude and longitude of the two marked sites on their smaller charts and record the latitudes and longitudes on their charts. If there is sufficent time at the end of the period at this station, the volunteer will also help the students navigate with a compass rose and parallel rulers.

SUMMARY OF ACTIVITY: PART C - CIRCULATION PATTERNS

The students will study a diagram of the water circulation pattern in Kachemak Bay and lower Cook Inlet and work with volunteers to develop an explanation for the pattern of currents and fresh and saltwater gyres and how these would affect the movements of nutrients and marine plankton in the bay.

HOW ACTIVITY RELATES TO THE MISSION:

Part A: Tides The students will learn or refresh their memory about reading a tide table to become aware of the large tidal range in Kachemak Bay. They will discuss the implications of this tidal range for conditions for living things and in choosing a site for an oyster farm.

Part B: Charts. Students will learn to read the nautical chart for information that will help them decide where to place their oyster farm. They can see if there are physical situations they should be aware of and avoid such as shallow water depths or outlets from streams, especially glacial ones. Students running an oyster farm must be able to read a nautical chart. The chart will help them describe the physical location of their oyster farm using latitude and longitude and navigate from Homer to the site.

Part C: Circulation Patterns. The circulation pattern in Kachemak Bay is complex because of ocean currents, tides, freshwater currents, and the influence of Homer Spit. Students will learn about the circulation patterns of salt and fresh water and consider the effects of this pattern on the distribution of nutrients, plankton (oyster food), and water of different salinities in the bay in terms of choosing a site for an oyster farm.

ACTIVITY #7: Gull Island Observations

SUMMARY OF ACTIVITY:

While standing on the bow of the boat, the students will look at the birds of Gull Island. They will listen to the captain tell about the eating, nesting and flying habits of all the birds. While watching the birds, the students will continue to fill out the Marine Watch activity sheet.

HOW ACTIVITY RELATES TO THE MISSION:

Gull Island is a bird rookery in Kachemak Bay. The presence of this rookery in Kachemak Bay is an indication of the rich and diverse food web in the bay. Their "guano" produces a tremendous amount of nitrogen needed by the plankton for photosynthesis The students will observe and identify the birds of Gull Island and learn about the natural history and food web relationship of the birds and marine mammals.

Birds of Gull Island:

a. Tufted Puffin
b. Horned Puffin
c. Pelagic Cormorant
d. Red-faced Cormorant
e. Black-legged Kittiwake
f. Pigeon Guillemot
g. Common Murre
h. Glaucous-winged Gull
i. Northwestern Crow
j. Bald Eagle

Marine Mammals that may be observed:

a. Sea Otter
b. Stellers Sea Lion
c. Harbor Seal

ACTIVITY #8: Visiting an Oyster Farm

SUMMARY OF ACTIVITY:

The students will look at a "typical oyster farm" in Kachemak Bay from the bow and starboard side of the boat. An oyster farmer will briefly tell the students about oyster farming in Kachemak Bay. He/she will show examples of equipment used "on a farm." The students will be encouraged to ask questions about starting a "class oyster farm" and growing oysters.

He/she will show and tell the students things like:

a. what an oyster looks like
b. examples of oysters at different ages
c. the special trays and lantern nets the oysters are raised in
d. what types of things are in Kachemak Bay that can harm the oysters or make them unsafe for people to eat (predators, silt, PSP, sewage waste, etc.)
e. what the farmer does to protect oysters from some of the harmful things
f. what equipment they might need on their "farm"
g. the special water conditions that are needed to grow oysters

HOW ACTIVITY RELATES TO THE MISSION:

The students have an opportunity to see first hand how oysters are farmed in Kachemak Bay.

ACTIVITY NAME #9: Microscope Station

SUMMARY OF ACTIVITY:

The students will make slides from water samples from both the north side and south side plankton tows. They will view these slides under compound microscopes and decide 1) if plankton (oyster food) is present in one area, both areas or in neither area, 2) what kind of plankton is present, distinguishing phytoplankton from zooplankton and "permanent plankton" and "temporary plankton" that are the early life stages of marine animals, and 3) determine which water depth contains the greatest amount of plankton. They will have an opportunity to view and identify plankton as a group using a videomicroscope.

HOW ACTIVITY RELATES TO THE MISSION:

Before making a decision on where to place their oyster farm, the students should know if plankton (oyster food) is available for their oysters in only one area, both areas or in neither area. To do this, the students will look for plankton (oyster food) under the microscope using slides made from both the plankton tows taken from the north side and the south side of Kachemak Bay**.**

ACTIVITY #10: Crab Pots

SUMMARY OF ACTIVITY:

Students will participate in setting a crab pot and collecting data on the catch. A CACS volunteer will demonstrate setting the crab pot, describing what they are and how they fish for crab. The students will watch as a crab pot is "dropped" at two locations, one on the north side and one on the south side of the bay. The pots will be pulled later in the cruise and students handle and study the organisms collected in the "study crab pots". They will assist the volunteer in identifying the crab species, and sexing and measuring them. They may also observe other types of animals that are captured in the crab pots and discuss their possible food chain relationships to oysters.

HOW ACTIVITY RELATES TO THE MISSION:

The students will collect scientific data on the crab populations on the north and south sides of Kachemak Bay and learn that populations in a bay can change dramatically in just a few years in response to changing ocean conditions and harvests by people.

THINGS TO DO BACK IN THE CLASSROOM

REQUIRED CLASS ASSIGNMENT

WRITE A RESPONSE TO THE MISSION STATEMENT COMPLETE WITH REASONS WHY THE DECISION WAS MADE AND MAIL, FAX, OR EMAIL IT TO THE CENTER FOR ALASKAN COASTAL STUDIES at
P.O. Box 2225, Homer, AK 99603
Fax # 907-235-6668
Email Address: cacs@xyz.net

The last step should add "closure" to the initial classroom preparation and the boat activities. The "nuts and bolts" of the assignment (length, whether the entire class or each group writes a response, whether it is written, printed or typed, etc.) is up to you. The students will take this assignment more seriously if they know the "Oceanography people" EXPECT the students to send back this assignment and they will receive the results from all other classes that participate.

Assessment: Review and complete the KWL chart about oysters and oyster farming. Ask the students how they would go about determining where they would find subtidal clam beds in Kachemak Bay.

Communicate about the Trip

1. Arrange to show the PTA or classroom parents what happened on the Oceanography trip. Maybe:
    a) someone took a video of the trip.
    b) students could use their photos to create several posters showing what happened during the day or during a particular activity.
    c) have each group tell about one activity they took part in.
    d) have the students tell about the mission, the data they collected and where they finally decided to start their oyster farm.
    e) have the students "build an oyster farm" in the classroom.

****If either of these "sets of parents" were involved in the funding for the trip, they might like to see what the money was spent on. Also, if they liked what they saw, they may be more easily persuades to contribute money next year when you ask.

2. Invite students who might be in your class next year to come and look at the class oceanography "exhibit." It may give the "new" students something to look forward to, if you decide to do the Oceanography Program again.

Review Activities

1. Review the mission and discuss how each activity helped the students gather information for the mission.

2. Discuss the answers to the students mariculture questions.

3. Review the OCEAN bingo card. Have the students explain which items listed on card could affect the water quality.

4. Bring the plankton samples back into the classroom and look at them again or watch the videotape from the videomicroscope and identify the species. Use the illustration of "Common Plankton of Kachemak Bay".

   Questions for discussion:
   a. What colors did you observe?
   b. Why are so many plankton transparent? (camouflage in the water)
   c. What was the most plentiful organism you saw?
   d. Do you think these organisms stay the same size, or do they change? (Larval forms of marine invertebrates and fish metamorphose into larger, different forms while protozoa and many one-celled plants and animals remain the same size.)
   e. Will the organisms be in seawater at different times of year? (Plankton are only present when there's enough sunlight to support photosynthesis. Light levels are too low and day length too short in Cook Inlet during winter.)

5. Show the students a world map and ask them to predict other places in the world where "extreme" tides may occur. (Long, narrow inlets or other areas where tidal flow is constructed by the shape of the land.). Have students research Anchorage's bore tide and explain why it occurs where it does.

6. Study the chart of Kachemak Bay for additional information.

Extensions for Specific Activities

Oyster Farming

Get some samples of oysters from an oyster farm and grow them in a classroom aquarium. Mark each shell with a number. Measure each shell once a week for the entire school year to see how fast the oyster will grow.

Marine Watch and Gull Island Visit

1. Have students research the sea otter, a common Kachemak Bay mammal.

2. Review the list of birds you saw at Gull Island and other locations in Kachemak Bay. Have students do additional research on how these birds nest, feed, swim, and possibly where they migrate from.

3. Participate in the Sisters Shorebird network to track bird migration through Kachemak Bay (http:www.fws.gov/r7enved/sssp.html).

Water Testing - Transparency/Turbidity

Make a Secchi disk and take readings in ponds, lakes, and streams. Take readings at different times (after a heavy rainfall, right after break-up, just before freeze-up, etc.) to observe seasonal and daily changes. (Start your own "stock" of oceanography equipment. Make a different piece of equipment each year.)

Tides, Currents, and Charts

Have students research and develop a map of major ocean currents along the Alaska coast and in the world's oceans. Indicate which currents are warm currents and which are cold currents and discuss how this affects the conditions for life.

Crab Pots:

1. Request the CACS crab pot data from past years and analyze the trends with respect to Tanner and Dungeness crabs in the catch and males and females in the catch.

2. If you have a beach field trip, look for a crab molt. Ask students to brainstorm what they think they found. (You can tell a molt from a dead crab by attempting to lift off the top part of the shell. If it lifts off easily and the shell is light, it's a molt. A dead crab will have heavy bits of flesh inside the shell and a pungent odor.)

3. Have students write a story about a crab molting.

4. Have students make a papier-mache or clay model of a crab molting.

More Oceanography Curriculum Resources

"Visit to an Ocean Planet" CD-ROM for grades 6-12 has a focus on the TOPEX/Poseidon satellite project to measure ocean topography and current patterns. The CD has background information, images, movies, and lesson plans for the topics of Oceans, Life, and Climate and the themes of Measurements, Systems and Interactions, Scale and Structure, Energy, and Process and Change.

NSCAT "Winds of Change" CD-ROM for grades 6-8 has a Global Climate Change Curriculum in subjects of Earth Science (ocean, weather, climate), Physical Science (atmosphere), and Life Science (Living Things). The CD has background information, images, movies, and lesson plans for each topic organized around questions related to the same themes as the "Ocean Planet" CD plus Human Interactions, Stability, and Evolution.

Education Resources for Oceanography and Earth Sciences – 40+ page on-line document for K-12 and college educators contains links to resources in oceanography and earth system science.

Free copies of these resources are available to teachers. Order over the Internet at www.jpl.nasa.gov/education/poster.

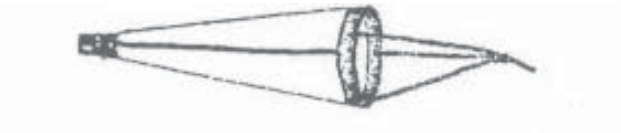
The Maury Project has a peer trainer program and single topic teaching materials for physical oceanographic education. The Alaska contact is Gary Cooper, HC 60, Box 3530; 1954 Davenport Rd., Delta Jct., AK 99733 Phone; 907-895-4577, Fax: 907-895-4577, Email fggc@dgsd.k12.ak.us

Appendix A

VOCABULARY

1. APPENDAGE	a structure that "sticks out" from the main body, e.g., arms or legs.
2. AQUACULTURE	synonym for mariculture, fish farming or shellfish farming.
3. BIRD ROOKERY	a breeding place for birds that nest in colonies.
4. BIVALVE	having two shells (be=two, valve=shell).
5. COMPASS	an instrument that points to Magnetic North and shows the heading the boat is traveling.
6. CURRENT	movement of water or air in a definite direction.
7. DENSITY	average number per unit of volume.
8. DEPTH FINDER	an instrument that tells how much water is under a boat.
9. ENVIRONMENT	the place where an organism lives.
10. FILTER FEEDER	animal that moves water into their body usually by use of cilia to create currents, select food items usually plankton and detritus, reject nonfood items, and expel them back into the water.
11. FISH FARMING	synonym for mariculture, aquaculture.
12. FOOD CHAIN	a series of plants and animals connected by their feeding relationships. A complete food chain includes a producer, consumer, and decomposer, and the sunshine and nutrients required by the producer.
13. FOOD WEB	a series of interconnected food chains that show the feeding relationships between many plants and animals.
14. G.P.S.	Global Positioning Unit – an instrument that tells the latitude and longitude of an object like a boat, by receiving signals from a triangulation of locations from satellites.
15. GUANO	excrement from birds.
16. GYRE	area where water and matter suspended in it moves in a circular motion.
17. HELM	the place where the captain sits and drives the boat.
18. LANTERN NET	a net for growing oysters which is shaped like a Japanese lantern.
19. LARVA	the immature ("baby"), free-living form of an organism that changes in appearance when it becomes an adult.
20. LATITUDE	a north/south distance locator measured in degrees north or south of the equator.
21. LONGITUDE	an east/west locator measured in degrees east or west of Greenwich, England.

22. LORAN	an instrument that tells the latitude and the longitude of an object like a boat, by receiving signals from a grid of land-based stations.
23. MARICULTURE	growing of fish or shellfish in an artificial environment; synonyms are aquaculture, fish farming or shellfish farming.
24. MARINE	refers to salt water.
25. MICROSCOPIC	something so small it cannot be seen with just human eyes. It will need a special instrument like a microscope to be seen.
26. MOLLUSCA	the phylum to which "soft bodied" animals, like clams and oysters belong.
27. NAUTICAL CHART	a marine map.
28. NUTRIENTS	minerals and elements needed for growth and reproduction by organisms, such as nitrogen, phosphorus, and calcium.
29. ORGANISM	refers to either a plant or an animal.
30. OYSTER	a member of the phylum Mollusca, a filter feeder and a bivalve.
31. pH	a measurement of the relative acidity or alkalinity of a substance.
32. PHOTOSYNTHESIS	the process by which plants use sunlight, carbon dioxide, water and chlorophyll to make food.
33. PLANKTON	microscopic marine organisms which either cannot swim or are weak swimmers and therefore can only drift and float with the waves.
34. PLANKTON TOW	a device used to collect a sample of plankton.



35. PHYTOPLANKTON	plankton that can photosynthesize.
36. RADAR	this instrument helps the captain "see" where the land is and how far away it is.
37. RADIO	an instrument that helps the boat captain communicate with people on shore.
38. SALINITY	the concentration of salt in the water.
39. SAMPLE OF PLANKTON	a small amount of plankton collected from an area.

40. SECCHI DISK	an instrument used to measure the transparency of the water (how deep sunlight penetrates into the water).
41. SHELLFISH FARMING	synonym for mariculture, aquaculture.
42. SUSPENSION CULTURE	a method for growing oysters in which the oysters are suspended in nets in the water.
43. TEMPERATURE	the measure of the warmth or coldness of an object.
44. TURBIDITY	the concentration of substances that block the penetration of light through water.
45. UPWELLING	a phenomenon where nutrients from the bottom of the water are brought to the surface by a combination of dominate winds in the area and the Coriolis effect.
46. WEATHER CONDITIONS	atmospheric conditions like: sunny, rainy, cloudy, foggy or windy.
47. ZOOPLANKTON	Plankton that are animals.

Appendix B

Kachemak Onboard Oceanography Program
Addressing Education Standards

The Center for Alaskan Coastal Studies is committed to excellence in its school education programs embodied in national and state standards for content, teaching methods, and assessment. Meeting these standards will require a long-term process of systemic reform and cooperation with teachers, school systems and education support communities. Our field-based program presents students with powerful experiential learning opportunities, however preparation and follow-up are critical to ensure the student achieves understanding of the concept. We also recognize that while single teaching activities and units can address multiple objectives in relation to content, full understanding of the concept described by each standard will likely require repeated exposure to the concept in a variety of ways.

As a first step, we have identified state science content standards that our Kachemak Oceanography program currently targets. We welcome feed-back from teachers as to the pre- and post-field trip activities they use to address these learning objectives. We plan to compile this information into a resource for other teachers and educators.

At the core of the national science standards is the promotion of inquiry-based science. They recommend less emphasis on knowing scientific facts and information and more emphasis on understanding scientific concepts and developing abilities of inquiry. In terms of learning activities, they recommend less emphasis on activities that demonstrate and verify science content and more emphasis on activities that investigate and analyze science questions; less emphasis on getting an answer and more emphasis on using evidence and strategies for developing or revising an explanation; less emphasis on providing answers to questions about science content and more emphasis on communicating science explanations. Our programs have embraced this philosophy.

A CACS program that does this is the six-hour Kachemak Bay Oceanography program. It is an extended inquiry into the question of whether the north or south side of Kachemak Bay is a better place to site an oyster farm. Students review the biological and chemical requirements of oysters and the physical requirements of an oyster farmer, then develop their inquiry skills by collecting information and comparative data in a variety of ways. They develop and investigate a series of science questions: Which area has the salinity that is in the desireable range for oysters? Which area has a pH in the range? Which area has the most plankton for oysters to feed on? How do the currents in Kachemak Bay move the plankton around in the bay? As they collect and eventually analyze their data, they use the evidence to develop and communicate the explanation of their final decision.

The Alaska Science Standards are comprised of broad content standards in the areas of specific content (facts, concepts, principles, and theories), skills of scientific inquiry, the nature and history of science, and the application of scientific knowledge and skills to make reasoned decisions about the use of science and scientific innovations.