Kachemak Bay Oceanography
Pre-trip Packet for Teachers

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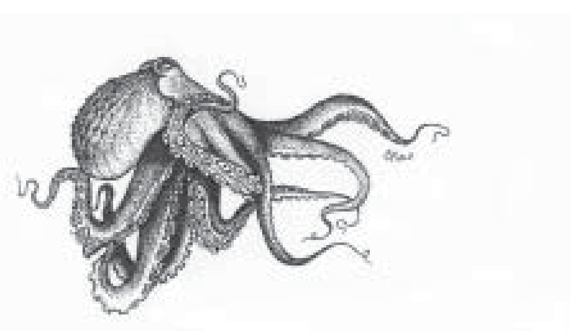

Center for Alaaskan Coastal Studies
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Checklist for What You Need to Bring

_____ One set of Activity Sheets and a pencil for each group. This works best if you put them on a clipboard and attach a pencil to the clipboard.

_____ Binoculars, if available - for Marine Watch and Gull Island activities

_____ Student-made Plankton Tow (optional, see “how to make” sheet in this manual)

_____ Blank videocassette (optional, to take home stereomicropscope footage)

_____ Video camera (optional)

_____ Jars, fixative, and labels (optional, to view plankton again with microscopes)

BEFORE THE OCEANOGRAPHY TRIP

1. **Give chaperones copies of the "Introduction for Chaperones" sheet before the trip. Remind the chaperones that the CACS volunteers need their help to:**

- Stay with their group to make sure the group gets to the correct activity, at the correct location in a reasonable amount of time and with the group's activity package and pencil.
- Make sure the students in their group are dressed appropriately for the weather - coats, hats, gloves rainjacket.
- Help keep everyone in their group focused on the particular activity.
- Make sure the students in their group are holding on in case the weather turns rough.

2. **You will be contacted by Rainbow Tours and given a boat departure time from the Homer Small Boat Harbor. Plan your travel to arrive 30 minutes before the boat is to leave.**
This allows time for the CACS volunteers and the crew to talk with the students and chaperones about the day and safety on the boat. The "students' gear" can be stored in uncrowded and unrushed conditions.

3. **Have the students divided into 5 groups with one chaperone for each group.** Most classes have about 25-35 students. (If you have a larger class, divide them into 6 groups.) Groups of no more than 7 students allow for everyone to be able to participate in each "hands on activity". If you will have a larger group, CACS will contact you to plan a modified program.

4. **Be prepared to carry out the class assignment that is the last step in the Oceanography program.**
Respond to the question in the mission statement and give your reasons. This activity provides "closure" to the initial preparation and the boat activities and a means to evaluate your students' critical thinking skills. You can decide the "nuts and bolts" of how you want your students to complete the assignment (length, whether the entire class or each group writes a response, whether it is written, printed or typed, etc.) Please send written responses to CACS - the students will take the entire Oceanography trip more seriously, if they know the "Oceanography people" in Homer, EXPECT the students to "mail" back this assignment.

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Typical Schedule

A typical "floating classroom" could look like this. The teacher will be contacted and the schedule arranged based on the teacher's desires and tides.

8:45 On the dock before the boat leaves, talk to all about the day and boat safety

9:00 Leave harbor, crab pot discussion

9:20 Drop the crab pot on the north side of the bay

9:20 Do the 5 activities on the north side of the bay
Helm, charts, secchi disk and pH, plankton tow, water sampling

10:00 Drive to south side of bay. While en route the helm and marine watch activity will occur

10:30 Do the 5 activities on the south side of the bay
helm, charts, secchi disk and pH, plankton tow, water sampling

11:00 Drive to the oyster farm in Peterson Bay

11:15 Oyster farm presentation

11:45 Drive to Peterson Bay dock and tie up for lunch and afternoon activities

12:00 Lunch

12:30 Afternoon activities
Microscopes, secchi dick and pH, water sampling, charts

1:00 Rotate groups and do the same afternoon activities

1:30 Leave the dock at Peterson Bay to pull the crab pots on both the south & north side of bay

3:00 Back in Homer harbor

Ideas for Pre-trip Classroom Activities

Students will be able to make the most of their time spent onboard the Rainbow Connection doing “hands on” activities if they come prepared with some basic concepts.

- **Oyster Farmers Need:**
  - ◊ Food for the oysters
  - ◊ The right water conditions (salinity and pH)
  - ◊ Clean water (free from pollution that harms oysters or people who eat oysters)
  - ◊ A good site for the farm that combines all of these factors and others
- Food chains and the role of sunlight, nutrients, producers, and consumers
- How oysters and other filter feeders obtain plankton as food
- Tidal cycles and what causes them
- Bays or estuaries as places where salt water from the ocean and fresh water from rivers meet and mix
- Latitude and longitude
- What water pollution is and what types of pollution are harmful to oysters or to the people who eat them.

The activities described below are suggestions for this preparation of your students.

Setting the Stage - Oysters and Oyster Farming

Pre-Assessment:
Develop a KWL Chart about oysters and oyster farming. Brainstorm what students know about these topics and what they would like to know. After you return, you can fill in the last column what students learned.

1. Explain the mission of the Oceanography Cruise.

2. Discuss with the students what mariculture is and the natural history of oysters

3. Discuss how oysters are farmed in Kachemak Bay based on the Background Information.

Food for Oysters - Plankton

1. Lead a food chain or food web activity with students. Students should be able to describe a food chain and the role of sunlight, mineral nutrients, producers, consumers, and decomposers.

2. Read about the importance of plankton from the Teacher Background section of this manual. Discuss what plankton is with your students and why it is important to oysters and marine and intertidal food chains and webs.

3. Discuss the role of seabirds in Kachemak Bay food chains. Point out the role of their guano in contributing nutrients to food chains and webs.

4. List plants and animals in Kachemak Bay and have the students make food chains and a food web out of them. (See examples)

5. Have the students describe a food chain involving an oyster. (Plankton-oyster-human or plankton-oyster-starfish)

6. Ask students how deep in the bay you should sample for plankton. (As deep as sunlight can penetrate for photosynthesis by phytoplankton which will, in turn, be fed on by zooplankton.)

7. If a microscope is available in the classroom, practice making slides from pond water, picking out organisms and drawing organisms. Identifying each organism as either zooplankton or phytoplankton is also good practice.

The Right Water Conditions

Salinity

1. Demonstrate the concept of salinity by mixing salt solutions with different concentrations of salt. Explain the measurement unit of "parts per thousand."

2. Discuss the salinity of fresh water and ocean water. (Distilled water has a salinity of zero; fresh water has salinity close to zero and ocean water has a salinity of 35 ppt.)

3. Ask students to make predictions about the salinity of Kachemak Bay.
   a. How does salt get into Kachemak Bay? (from the ocean)
   b. Would you expect Kachemak Bay to have the same amount of saltiness everywhere in the bay? (No, because large rivers flow into the bay and bring lots of fresh water into some areas and tides and currents move the fresh water around.)
   c. Would rain or snow make any difference in the salinity? (It could change the surface salinity temporarily if it falls on the bay. If it falls on the land, it will increase runoff of fresh water and could lower the salinity near the mouth of streams)
   d. What happens when water evaporates? (This would increase salinity if the water was isolated such as in a tidepool, but probably has little effect on a large bay where water is being moved around by tides and currents.)

4. Ask students to think about plants and animals in the ocean. Do they think they can tolerate large changes in salinity? (No, plants and animals are adapted to a certain range of salinities - most are either primarily ocean-dwelling or primarily land-dwelling because it is so hard to make a transition. Salmon are an exception, but they must spend periods of time adjusting when the smolts migrate from the rivers to the ocean and the adults return.)

SALINITY
WORK SHEET

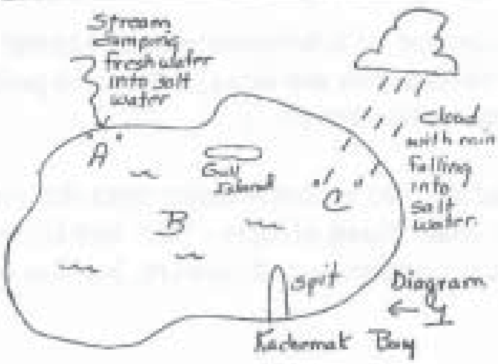
Study the diagrams below. Then read each statement and decide whether it is TRUE or FALSE.

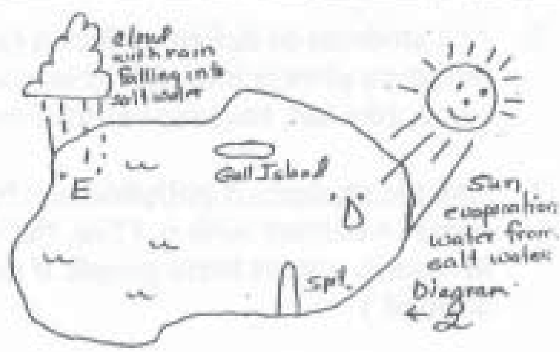
1. In diagram 1, area A would be saltier than area B.

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.

pH

1. Students should be prepared for this field trip activity with a basic understanding of what the pH scale is and know at least one example of a strong acid (e.g., vinegar)and a strong base (e.g., household bleach)

2. Explain to students that acids and bases can be a form of pollution that can make waters unlivable for plants and animals. Describe the process of acid rain formation.

Clean Water

1. Discuss why clean water is important for plankton (oyster food), oysters, all marine organisms, and people.

2. Ask students to define pollution (an increase of a substance over natural levels). Is pollution always harmful? (No, some substances are always harmful poisons, and some, like silt, become harmful only at certain levels .)

3. Ask the students if pollution can be harmful to animals other than the ones that first come in contact with it. (Yes, through food chain effects - PSP and bacteria that live in human wastes harm people if they eat contaminated oysters, but the oysters are not harmed.)

4. Review your list of questions for the oyster farmer to see if you want to add some about water quality.

Turbidity/Transparency

Look at a map or chart of Kachemak Bay and ask students to predict where the depth of light penetration might be blocked by a lot of silt in the water. (where streams flows are carrying mud from the land, especially glacial streams during summer and fall; where erosion is occurring)

Finding a Good Site - Tidebooks, Charts, and Circulation Patterns

1. Students should come with a basic understanding of the tidal cycle and what causes them so the time spent on this topic during the field trip is a review.

2. Introduce students to reading a tide book. Discuss the importance of a tide book to beach walkers, boaters and/or oyster farmers. Have the students contruct a marigram of Kachemak Bay tides (Background and instructions for "Measuring the Tides" activity follows this section.)

3. Help the students learn and understand the definitions of a current, upwelling, and gyre.
   Current - the movement of water or air in a definite direction. The Alaska Current flows along the coast of Alaska from east to west. This current splits into two as it flows past the mouth of Cook Inlet, with one part moving up the Inlet and one part continuing to flow west toward the Alaska Peninsula and the Aleutian Islands.
   Upwelling - As plankton and other organisms die, their bodies rain down onto the bottom where they are decomposed by bacteria into nutrients. In certain areas,the colder, nutrient-rich water from the bottom of the ocean are mixed by winds into the warmer surface layer of the ocean where currents and tides move them. This phenomenon occurs at the Kennedy Entrance to Kachemak Bay and brings large amounts of nutrients into the upper layer of the bay where it is available to phytoplankton for photosynthesis.
   Gyre - whirlpool, place where water moves in a circle. In Kachemak Bay, gyres concentrate nutrients and plankton and increase the time they stay in the bay.

4. Show the students a variety of maps, like: a) a topographic map, b) a contour map, c) a "city" map, d) a nautical chart, e) a "state road" map, etc. Using these maps, have the students list the types of things each type of map can tell them.
   (You can download the nautical chart for Kachemak Bay from the World Wide Web site: http://mapindex.nos.noaa.gov/ Click on "Continue to Map Finder" and "Find Maps," then select "Nautical Charts" under "Themes" and "Alaska" under "Choose a state." Click "Go." Zoom in on the map of Alaska and click on Kachemak Bay. You may have to try several times, the server is often busy.)

5. Have the students make their own maps of imaginary places to demonstrate to them that a map can contain important pieces of information.

6. Give the students a map to "some treasure" that might be hidden in the classroom or outside. The students must use the map to find the treasure.

7. Practice finding the latitude and longitude of particular sites on a nautical chart, a globe, an atlas, etc. Discuss how the latitude and longitude acts like an address to help locate places on a map or chart.

8. Discuss with the students kind of things they should be looking for when considering a "site" for their oyster farm. Also discuss why these "things" would be important for an oyster farm. Some examples of "things" to consider could be:
   a) Are there streams or rivers close to their "oyster farm" site that could dilute the salt water?
   b) Could the streams and rivers deposit silt in the area of their oyster farm?" Is silt good for oysters?
   c)Are there places where there might be pollution from human activities? (e.g., heavy boat traffic --could leak fuel, drainage from storage of logs and log chips could put chemicals" into the water, etc.)?

Visiting an Oyster Farmer

Tell the students they will visit an oyster farm and have a chance to talk with an oyster farmer. Help the students come up with a list of questions to ask an oyster farmer, like:

1. How many oysters are on your farm at any one time?
2. What things can harm oysters or make them unsafe to eat?
3. How much food does an oyster need?
4. How fast does an oyster grow? How does it grow?
5. Does an oyster grow faster at a particular time of the year in Kachemak Bay? Why?
6. How deep can you grow oysters?
7. What is a pearl?
8. Have you found any pearls in your oysters? Why not?
9. Do oysters eat phytoplankton or zooplankton?
10. Is there a market to sell the farmed oysters? Where do you sell your oysters?
11. How much money can we make selling farmed oysters?
12. How much money does it cost to start an oyster farm?
13. How much money does it cost to run an oyster farm?
14. Are there special “tricks” to growing oysters?

Additional Pre-trip Activities

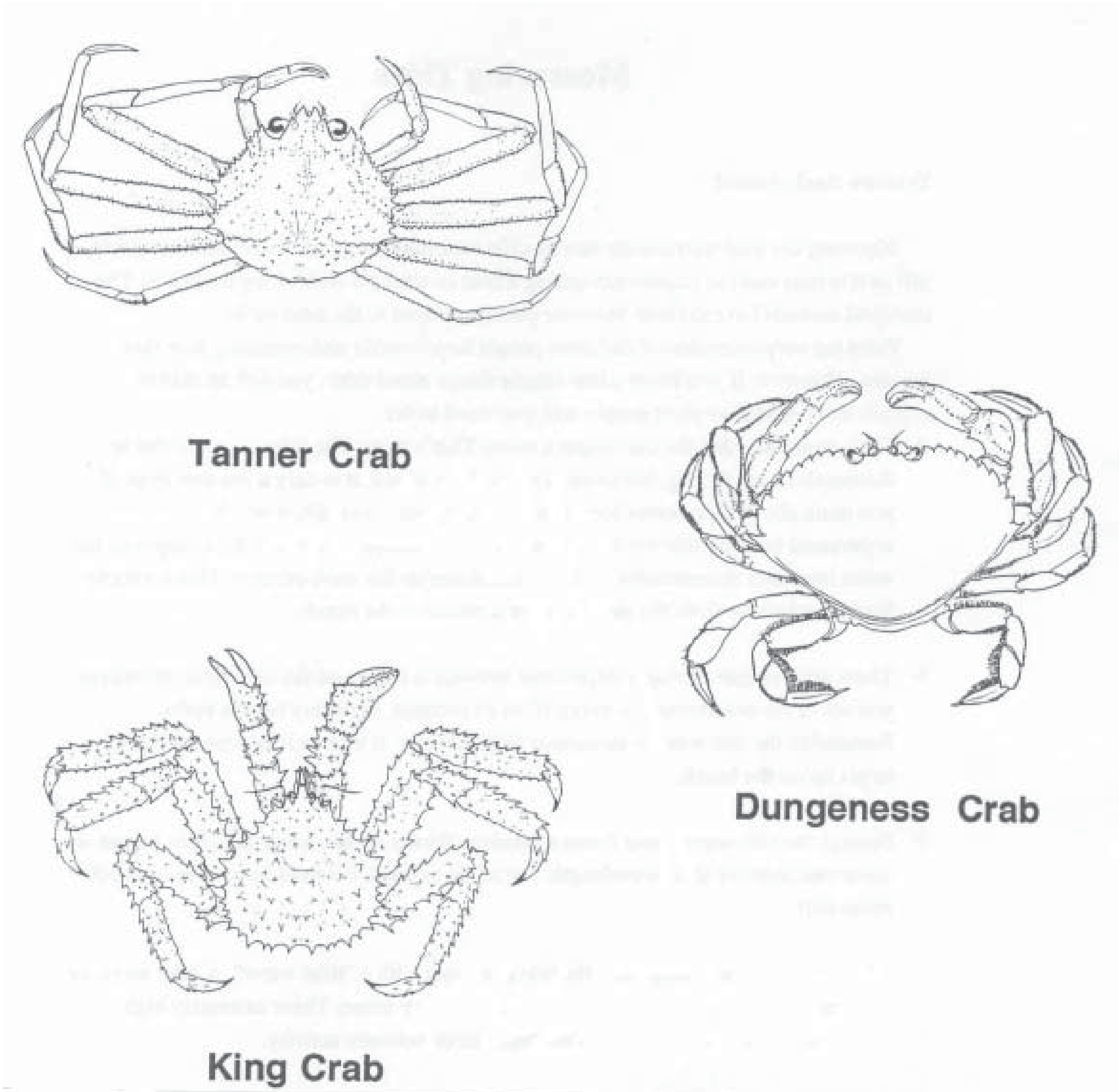
Birds of Gull Island

1. Have students research the birds listed on the Gull Island Data Sheet in bird guides, in encyclopedias, or on the World Wide Web. Have the students write one or two important identification characteristics about each bird to help them identify the bird while the bird is flying, floating in the water, or nesting on Gull Island.

2. Schedule a class visit to the Island and Ocean Visitor Center in Homer and/ or the Pratt Museum before or after your Oceanography cruise. A staff person or volunteer will lead activities about birds or other topics by arrangement.

Crab Pots:

1. Have students observe differences in the appearance of Dungeness, Tanner, and King crabs.(see next page)



. Discuss with the students:

a. What a crab pot is,
b. What a crab pot might look like
c. What scientific questions could be answered with data from crab pots
d. How crabs grow (molting)

Measuring Tides

Teacher Background

Knowing the tidal movements in a specific location is important to marine scientists, just as it is important to anyone navigating a boat or taking a walk along the beach. The intertidal animals have definite behavior patterns related to the tidal cycle.

Tides are very complicated and most people have trouble understanding how they happen. However, if you know a few simple things about tides, you will be able to explain them as well as most people will ever need to do:

- First, remember that the tide is just a wave. That's right. The tide is a wave that is thousands of miles long, but in most parts of the world, it is only a few feet high. If you think about what waves look like when they hit the beach, it will be easier to understand how the tide works. When a wave comes up on the beach, the depth of the water increases momentarily, and then decreases as the wave retreats. This is exactly how tides behave from the standpoint of a person at the beach.

- There are a couple of major differences between a wave and the tide. First, the waves you see at the beach come in every 10 to 15 seconds, not every twelve hours. Remember the tide wave is thousands of miles long. It takes a long time for the wave to get up on the beach.

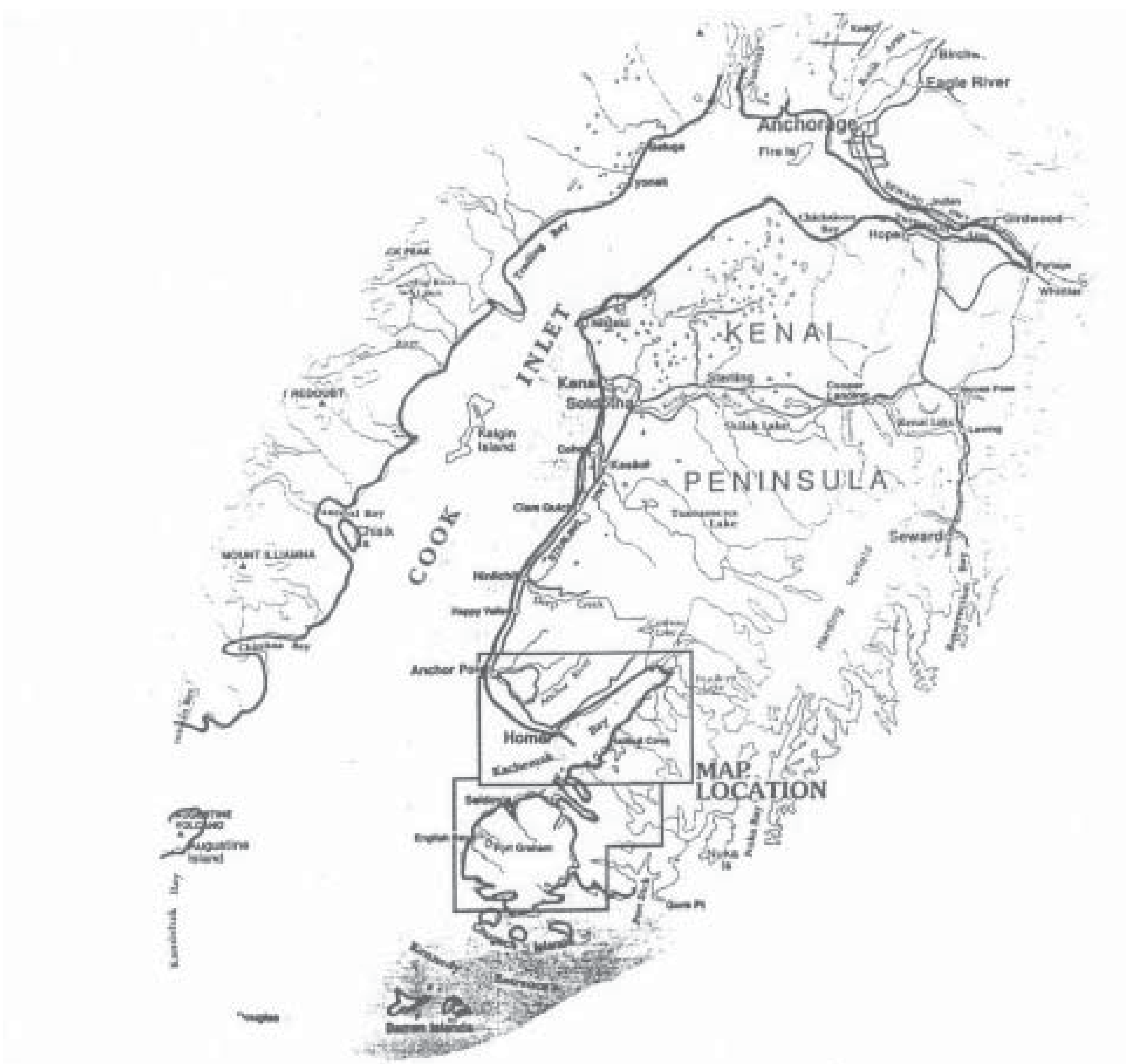
- Second, the tide wave never forms a breaker. Waves do not break until their height is about one-tenth of their wavelength. For a tide to break it would have to be over 1000 miles tall!

- Don't confuse the concept that the tide is a wave with a "tidal wave". A tidal wave, or tsunami, is neither a wave nor a tide in the ordinary sense. These extremely high waves originate with underwater earthquakes or volcanic activity.

- The tide levels that are shown in tidebooks are predictions only. They are useful, but seldom accurate. There are so many unpredictable things that affect the tides that, at best, the most we can expect of tide tables is that they will be reasonably accurate in calm weather and with a normal barometer reading.

- How far the tide comes up on a beach and how far it recedes depends on the slope of the beach. The same vertical height of water that rises and falls on a cliff during a tidal change will spread out horizontally as the slope of the shoreline varies from the vertical. Thus, a combination of extreme tides (large differences in the height of high and low tides) and flat or gently sloping beaches creates an intertidal zone that is much wider than the actual height of the tide.

- The height of the tide is different in different locations along the coast because of the shape of "basin" the wave must pass through as it comes in and recedes. If the wave is moving in and out from the open ocean to a straight shoreline, the wave spreads out to its flattest height. But if the same large volume of water moves through small bays, narrow channels, around convoluted shorelines, or through groups of islands, the height of the tide wave increases as it is squeezed through a narrower area. At its extreme, the tide comes in as a **bore tide**, a standing wave that moves faster than a human can run. Upper Cook Inlet is one of the few places in North America where bore tides occur. The map of Cook Inlet illustrates the features that contribute to bore tides.



Why *do* we have tides?

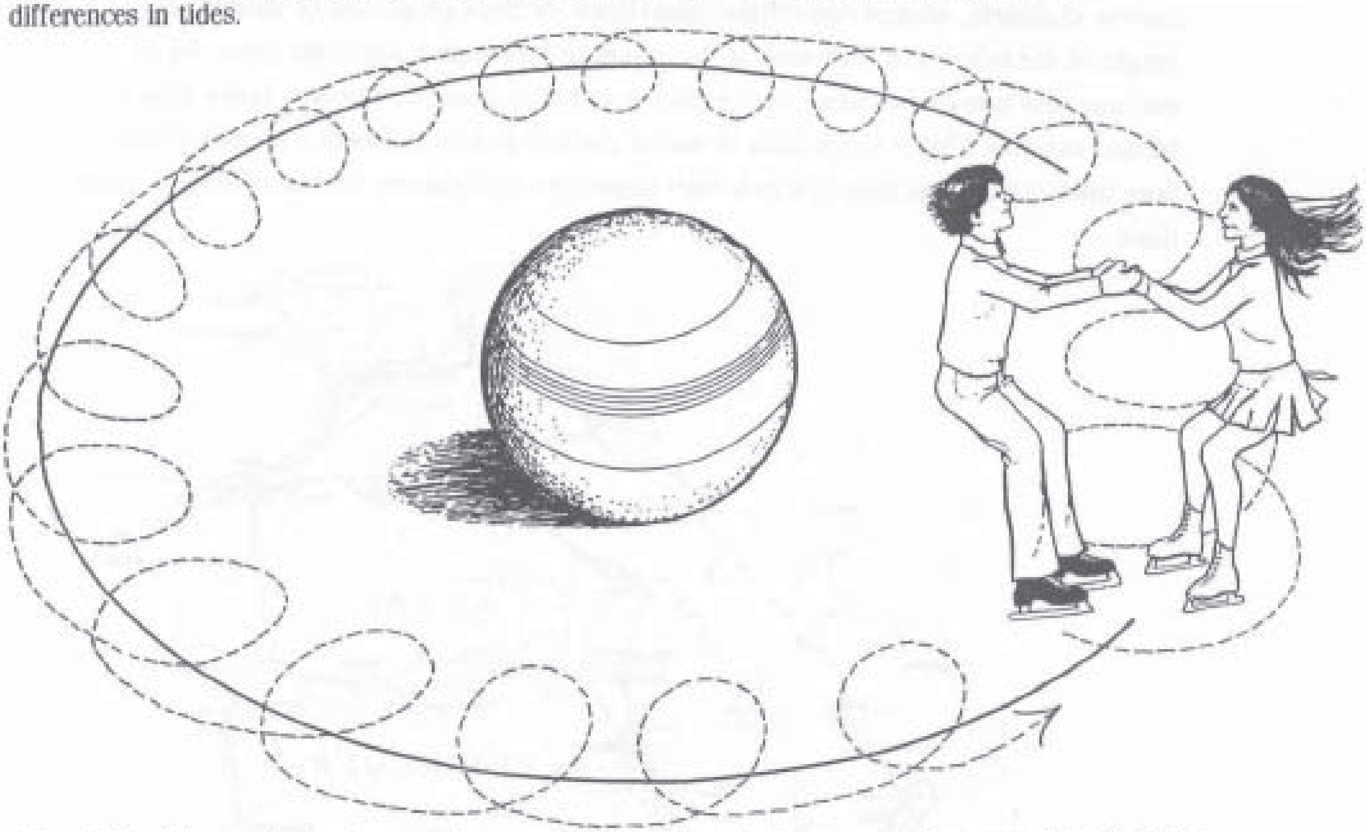
Tides are partly caused by the gravitational pull of the moon and sun on the earth's oceans. The moon's pull is about twice as powerful as the sun's because the moon is much closer to the earth. Ocean water collects on the side of the earth facing the moon because of the pull of the moon's gravity. When the water collects and increases, we have high tide.

Curiously, ocean water also collects on the opposite side of the earth, so there are two regions of high tide on the earth at any moment. Where does the water come from to give us a high tide? It is taken away from other areas of the earth, creating two low tides.

To understand why ocean water collects on the side of the earth opposite the moon, let's use our imaginations. We will learn that gravity and centrifugal force affect the tides in two ways.

If you were to spin a ball above your head on the end of a piece of string, you would feel the ball tug at the end of the string. If you let go of the string, the ball would fly away in a straight line. The force which makes the ball fly away is called inertia. Inertia is sometimes called centrifugal force.

You probably remember that the earth spins like a top and that if it were not for earth's gravity, centrifugal force would cause the oceans and people to fly off into space. This is the first way gravity and centrifugal force each affect the oceans. Another way to picture centrifugal force is to imagine a skater wearing a skirt and spinning like a top. Her skirt would stand out evenly on all sides. For this reason the earth spinning on its own axis does not cause differences in tides.



Two high tides each day happen because the Earth and the moon spin around each other.

From Sea Life at the Ocean's Edge by Pacific Northwest National Parks and Forests Assoc. in cooperation with Olympic National Park. 1984.

You may have learned that the moon rotates around the earth and that gravity acts like our string to keep it circling around the earth instead of flying off into space. But did you know the earth rotates around the *moon*?

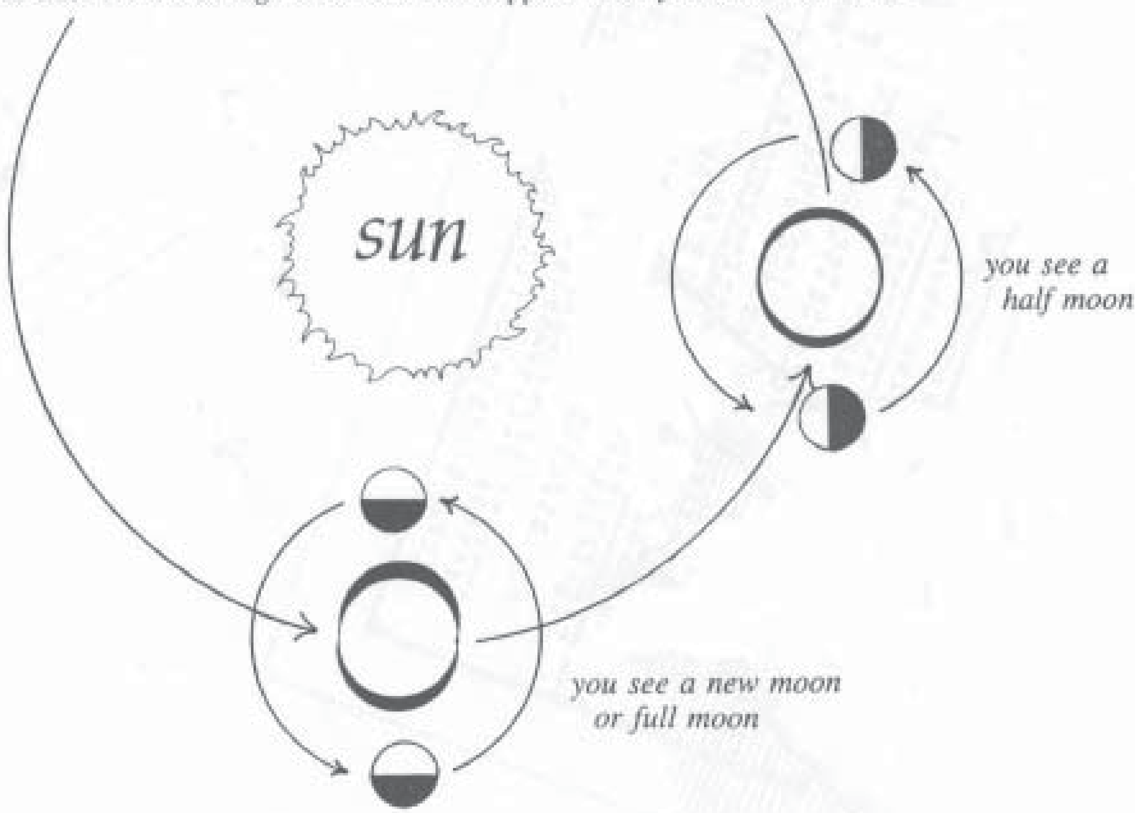
Imagine two ice skaters (the earth and moon) traveling in a large circle around a ball (the sun), while—at the same time—they are spinning around each other and holding on to each other's hands. We know that they are really circling around each other, but if one is a lot bigger than the other, it might appear as if the smaller one were only circling around the bigger one. That's the way it appears with the earth and the moon. The fact that the earth and the moon circle each other causes the second way gravity and centrifugal force each affect the oceans.

And just as the skaters each feel a tug in their arms, the moon and earth *both* feel each other's pull of gravity. The ocean water collects on the side of the earth facing the moon because of this pull.

Let's also imagine that each of our skaters has long hair. As they spin around each other their hair will flow outward. The girl's skirt will also press against the front of her legs and flow outward behind. The collection of water on the side of the earth opposite the moon occurs for the same reason that the hair and skirt flow outward. This is what creates the second high tide every day.

Why aren't tides the same size all year? The moon orbits around the earth, and the moon and earth orbit around the sun. But these heavenly bodies spin through space at different speeds. This means the earth, moon, and sun will line up differently at different times.

When the sun and moon are in a straight line with the earth, the pull of their gravities upon the earth is combined. The combined pulls result in both higher and lower tides on the same days. This is because more water is taken from low tide areas to create the highest tides. Two times a month the earth, moon, and sun will line up like this—during a full moon and during a new moon (a new moon is barely visible because it is between the earth and the sun and you just see the dark side of it). When the earth, moon, and sun are not lined up, the gravitational pulls do not combine, so tides are not as high or as low. This happens when you see a half moon.



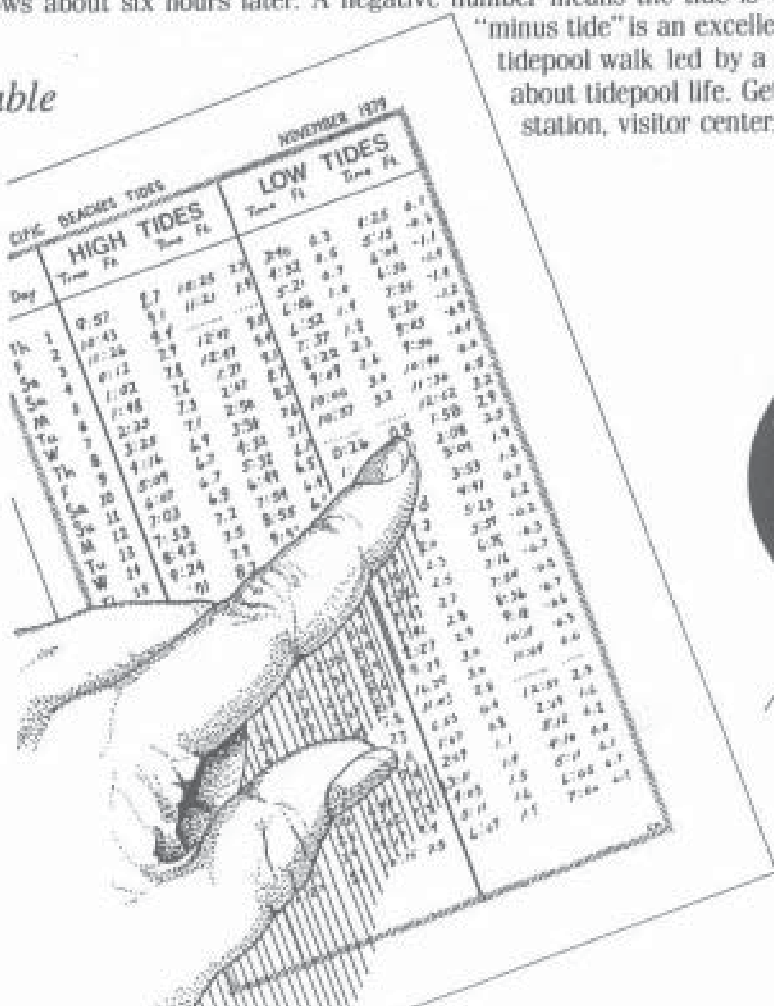
Another reason that tides are different throughout the year is that the moon's orbit around the earth is not a perfect circle. So when the moon is closer to the earth on its egg-shaped orbit, its pull is stronger.

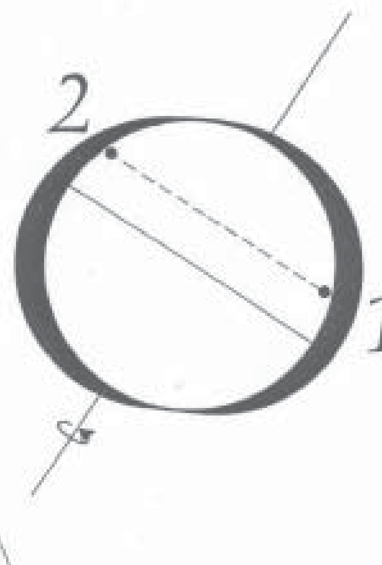
But why are tides sometimes different sizes on the same day? As the drawing shows, the earth is tilted on its axis as it rotates around the sun. Since both the sun and the moon affect tides, this tilt causes different size high tides. Suppose you were standing at position 1 in the drawing. About 12 hours later the rotation of the earth would bring you to position 2. At both positions you would see high tides, but the tide would be higher at position 1 than at position 2 because of the tilt of the earth. It also happens that the moon does not circle directly above the earth's equator, which also causes different size high tides. (This is a little harder to visualize, so we won't worry about it here.) Storms can also strongly affect the size of tides. So, a lot of things can affect tides.

Two high tides and two low tides occur every 24 hours and 50 minutes on Olympic's beaches. Why not every 24 hours? Every 24 hours the earth completes a rotation on its axis. In the meantime, the moon is not standing still. The moon travels around the earth every 28 days. So, when the earth completes a rotation at the end of 24 hours, the moon has moved. It takes the earth 50 minutes to catch up with the new position of the moon.

Scientists can usually tell us what the tides will be like next year. Look at the sample tide table. Find a date and read across. The numbers tell the size of the tides. Find the height of a high tide, and the height of the low tide that follows about six hours later. A negative number means the tide is very low. Right before and during this "minus tide" is an excellent time to explore tidepools. A summer tidepool walk led by a park naturalist is a good way to learn about tidepool life. Get this month's tide table from a ranger station, visitor center, or a newspaper. Practice reading it.

tide table





Constructing a Marigram

To understand how tides behave on a particular coast, scientists construct a graph of high and low tides. They measure the high and low tides using a tide gauge. The height of the tide can be read visually from a marked vertical stake on a dock or set up in quiet waters of a bay where it is not affected by surface waves. For long-term measurements, scientists mount a piece of scientific equipment that measures the height of the tide electronically and store the data for retrieval and downloading into a computer.

This graph of high and low tides is called a **marigram**, and has a variety of uses. Marigrams look very different in different parts of the world. Along the coast of Florida there is less than one foot of difference between high and low tide. In the Bay of Fundy in eastern Canada, the difference between low and high tide may exceed 50 feet. An interesting comparison is that the 100 billion tons of water moved in and out of the Bay of Fundy during each tide is the amount of water moved by the Mississippi River in 140 days.

Activity:

1. Using the information below, graph the high and low tides that will occur during the month of May, 2000, for the Seldovia tide district. Label the high tides and low tides for each day.

SELDOVIA DISTRICT — Seldovia, Kachemak Bay Alaska

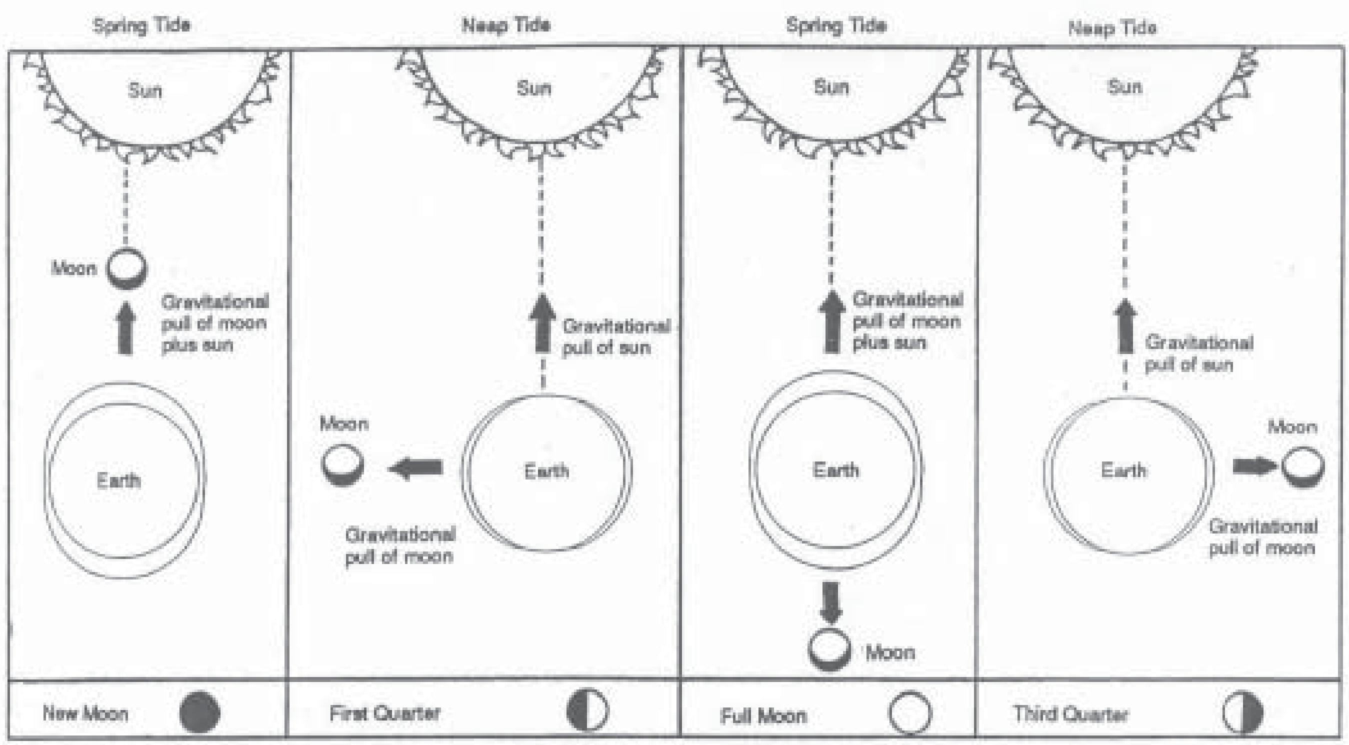
May 00	High Tides AM	FT.	PM	FT.	Low Tides AM	FT.	PM	FT.
1 Mon	1:21	17.0	1:38	16.6	7:30	1.4	7:39	1.0
2 Tue	1:55	18.5	2:22	18.0	8:09	-0.7	8:18	0.3
3 Wed	2:29	19.8	3:05	19.1	8:47	-2.5	8:57	-0.1
4 Thu	3:05	20.8	3:48	19.6	9:27	-3.9	9:37	-0.1
5 Fri	3:43	21.3	4:33	19.6	10:09	-4.6	10:20	0.3
6 Sat	4:23	21.2	5:20	19.0	10:52	-4.7	11:04	1.1
7 Sun	5:06	20.5	6:11	18.0	11:39	-4.0	11:53	2.2
8 Mon	5:54	19.2	7:08	16.8	......	......	12:31	-2.8
9 Tue	6:50	17.6	8:13	15.8	0:49	3.4	1:30	-1.3
10 Wed	7:57	15.9	9:26	15.3	1:55	4.4	2:38	0.1
11 Thu	9:17	14.7	10:40	15.5	3:16	4.7	3:54	1.0
12 Fri	10:44	14.4	11:44	16.3	4:42	4.0	5:07	1.3
13 Sat	......	......	12:02	15.0	5:54	2.6	6:08	1.2
14 Sun	0:36	17.2	1:03	15.8	6:51	1.0	6:58	1.1
15 Mon	1:19	18.1	1:53	16.7	7:36	-0.4	7:41	1.1
16 Tue	1:55	18.8	2:36	17.3	8:16	-1.5	8:20	1.2
17 Wed	2:29	19.2	3:14	17.7	8:52	-2.2	8:56	1.5
18 Thu	3:00	19.3	3:51	17.8	9:27	-2.5	9:32	1.9
19 Fri	3:32	19.2	4:28	17.6	10:01	-2.4	10:07	2.5
20 Sat	4:04	18.8	5:05	17.1	10:34	-1.9	10:43	3.3
21 Sun	4:37	18.1	5:43	16.3	11:09	-1.2	11:20	4.1
22 Mon	5:12	17.1	6:25	15.4	11:45	-0.3	......	......
23 Tue	5:49	16.0	7:10	14.5	0:00	5.1	12:24	0.8
24 Wed	6:32	14.7	8:02	13.8	0:45	5.9	1:09	1.9
25 Thu	7:26	13.6	9:01	13.4	1:40	6.6	2:02	2.9
26 Fri	8:33	12.7	10:02	13.7	2:49	6.8	3:05	3.6
27 Sat	9:52	12.5	10:57	14.4	4:05	6.2	4:13	3.7
28 Sun	11:07	13.0	11:45	15.6	5:13	4.8	5:15	3.5
29 Mon	......	......	12:13	14.2	6:08	2.9	6:09	2.9
30 Tue	0:29	17.0	1:09	15.6	6:56	0.7	6:58	2.2
31 Wed	1:11	18.5	1:59	17.1	7:40	-1.5	7:45	1.6

After constructing your marigram for Kachemak Bay, answer the following questions:

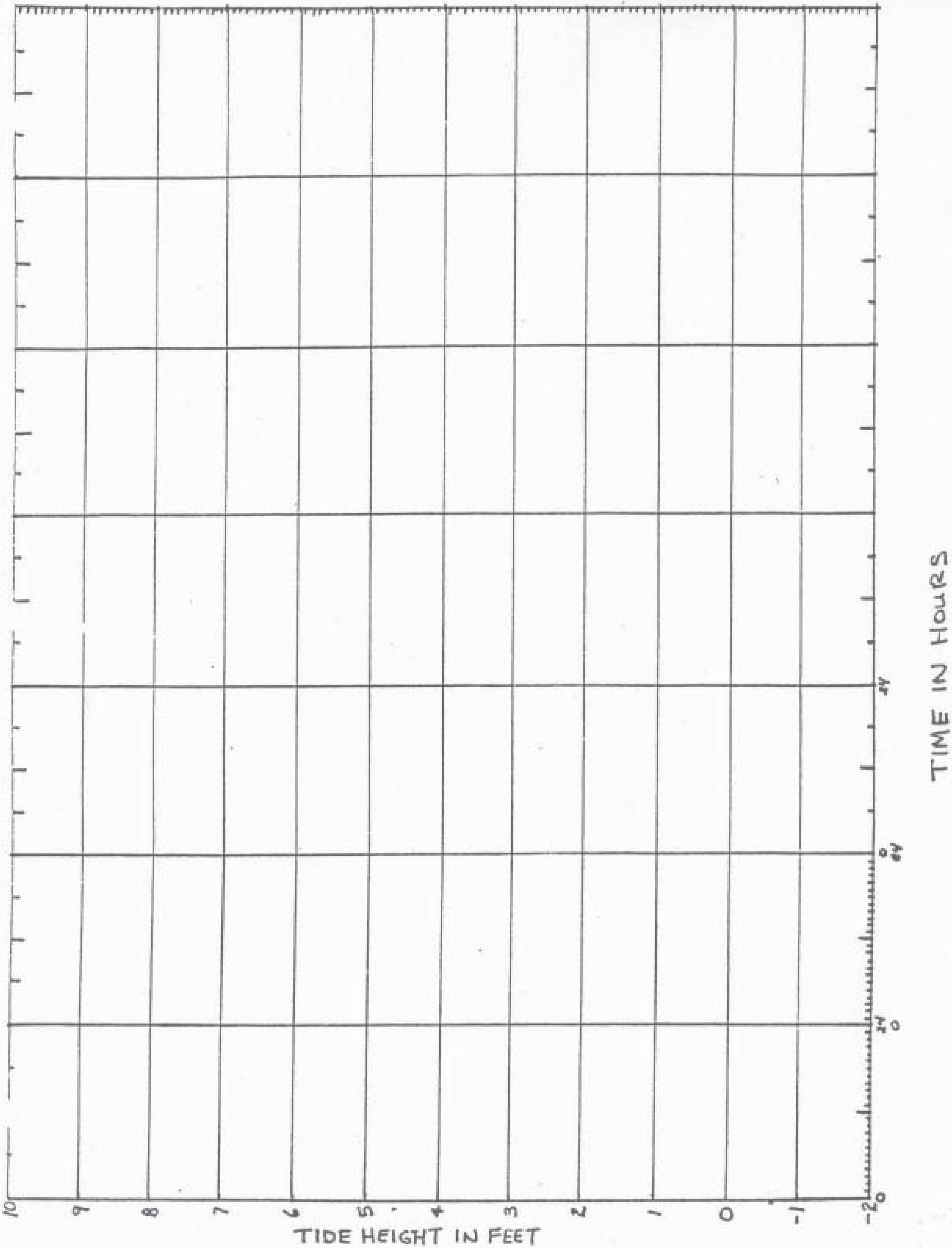
1. Why is it important to people to know about tides? Give some examples of people who use oceans and beaches who need to know about tides.

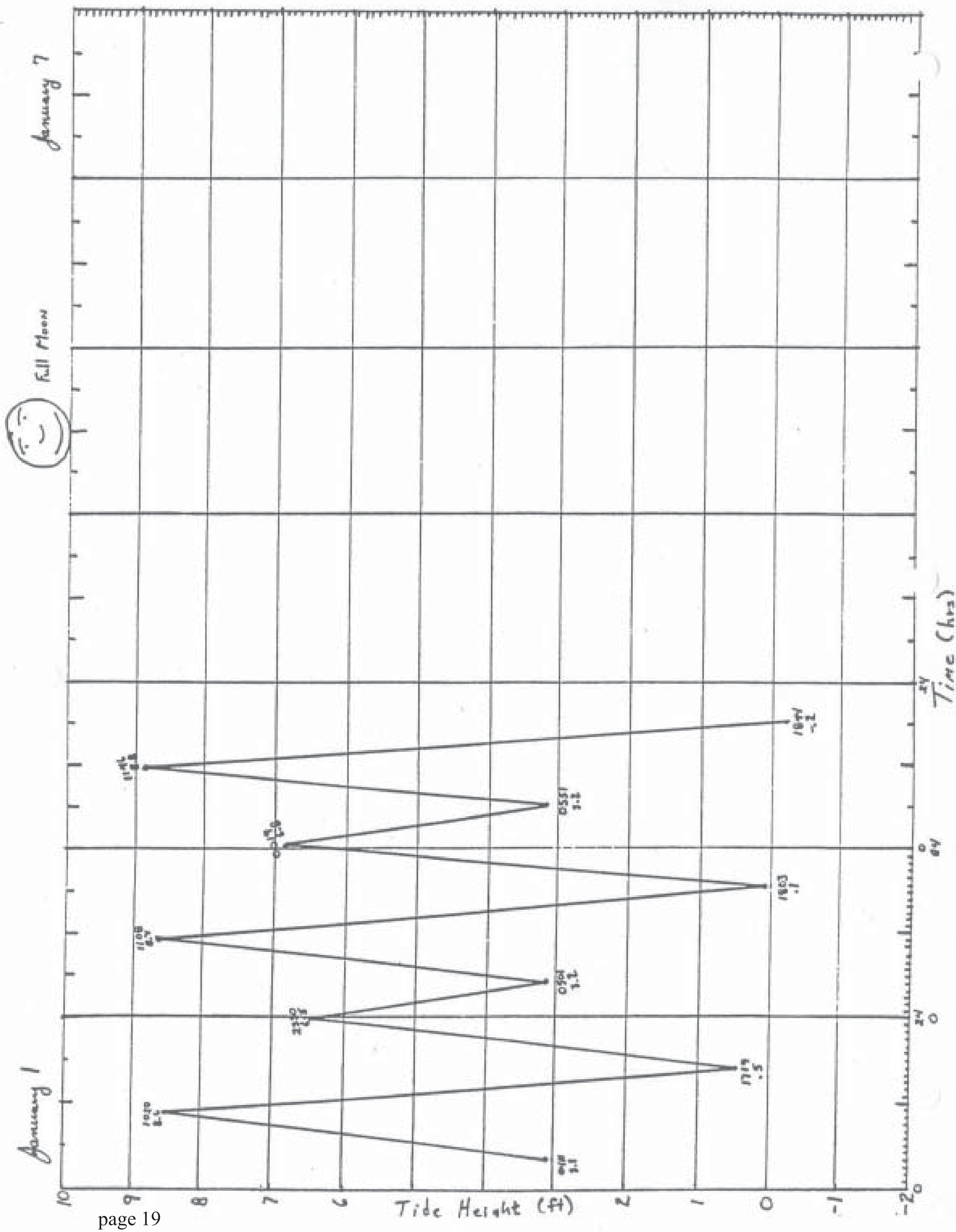
2. Calculate the average time between high tides. Can you explain why it is longer than 12 hours?

3. The moon is a primary influence on the tides and a tidal cycle lasts a lunar month of 29.5 days. Within this time period, there will be two sets of **spring tides** at new moon and full moon and two sets of **neap tides** at the first and last quarter of the moon. Look at the diagram below and write an explanation about why spring tides are the highest tides and lowest tides during the month. Label the spring and neap tides in your marigram.



4. What makes the intertidal zone (between low and high tide) such a changeable and dangerous environment in which to live?


TIME IN HOURS
TIDE HEIGHT IN FEET
10
9
8
7
6
5
4
3
2
1
0
-1
-2


January 1
January 7
Full Moon
Tide Height (ft)
Time (hrs)
10
9
8
7
6
2
1
0
-1
-2

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 related to Oceans, Life, and Climate and themes of Measurements, Systems and Interactions, Scale and Structure, Energy, and Process and Change.

Specific lesson plans that would prepare students for the Kachemak Bay Oceanography field trip include:

Movies - making a plankton tow	
Measuring turbidity with a Secchi disk	Life - Measurement
"Measuring Oceans"	Life - Measurement
"Classroom Communities"	Life - Scale
"Plankton Identification"	Life - Scale
"Carrot, Celery, Dehydration and Osmosis"	Life - Ecology
"CO2,O2, and Plankton" (relation to pH)	Life - Ecology
"Timing the Tides"	Ocean - Systems
"Wind-driven Ocean Currents"	Ocean - Systems

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.

Specific lesson plans that would prepare students for the Kachemak Bay Oceanography field trip include:

"Measuring Salt Concentrations"	Ocean - Measurement
"Why is the Ocean Blue?"	Ocean - Energy
"Properties of Fresh and Salt Water"	Ocean - Scale and Structure

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 http:/www.podaac.jpl.nasa.gov/edu/

Background Information on Oysters, Oyster Farming, and Plankton

*****Underlined terms are important vocabulary terms**

.

OYSTERS FARMING IN KACHEMAK BAY

Oysters are members of the phylum **Mollusca**. They are **bivalves** like clams and mussels which means they have two shells. They are **filter feeders** like most other bivavles which means they bring water into their body through a siphon, trap **plankton** and other particles in mucus, and reject nonfood particles and expel them through the siphon. Unlike the clams and mussels, oysters attach one of their shells permanently to a hard surface and lack a large muscular foot as adults.

The oysters that are cultivated on oyster farms do not live in Kachemak Bay under natural conditions. Even when brought here from areas where they do live, the water is too cold for them to reproduce. Scientists have found that they can live and grow in Kachemak Bay because of the large amount of food and suitable water conditions. They just will not reproduce and in fact, they grow faster and larger because they are not putting energy into reproduction. The clean water in Kachemak Bay is a good place for oyster mariculture because the risk of contamination that make the oysters unmarketable is low.

When a person grows fish or shellfish in an artificial environment, it is called **mariculture**, **aquaculture**, **fish farming or shellfish farming**.

The oyster farmers in Kachemak Bay usually buy baby oysters, or "spat" from oyster farmers in Washington or Oregon. They then place the spat which is growing on small pieces of oyster shell in a tray made of small holed wire. The tray is then placed in the nutrient rich waters of Kachemak Bay. The farmers tend their farms every day. The farmers have to wash the trays with holes to keep the silt and dirt from setting on the spat. They also have to keep sea stars, an enemy of the oyster, away. After about two months, the baby oysters are removed from the pieces of shell and placed in a **lantern net.** When oysters grow in a lantern net it is called a **suspension culture.**

Again the oyster farmer must rinse the oyster with a hose every few days to keep the oyster free of silt and dirt. Too much dirt on the oysters and they would not be able to filter out the food, plankton from the sea water. The oyster farmer must also keep the lantern nets free of algae and sea weed that may get tangled around the nets and block the plankton from the oysters. And don't forget the sea star. Oysters are one of a sea stars favorite food! Any sea star must be removed from inside and outside the lantern net.

When the oysters have grown to about 4 to 6 inches in size, they are about 2 to 4 years old. The oysters can then be harvested and sold.

WHAT CONDITIONS DO OYSTERS PREFER?

a pH of ………………………………………………….. 8-8.4

a salinity of …………………………………………….. 25-27 ppt

a water temperature of …………………………………. 5-9 degrees C.

a water transparency (turbidity reading) of …………….. 15-18 feet

lots of phytoplankton and zooplankton to eat

and lots of clean water (free from pollution that would harm them)

**Underlined terms are important vocabulary terms.

WHAT IS PLANKTON?

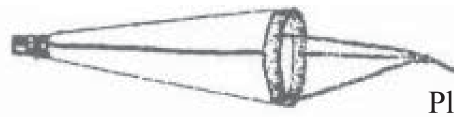
The marine waters contain a "nutrient rich soup" called plankton. The term plankton refers to microscopic marine organisms which either cannot swim or are weak swimmers and therefore can only drift and float with the waves. Some of these microscopic organisms are plants or phytoplankton. And some of these microscopic organisms are animals or zooplankton. Most of the organisms making up this special soup scientists call plankton are microscopic their entire lives. A few of the zooplankton, however, grow too large and too heavy to continue to drift with the waves and eventually "fall out" of the floating "plankton soup." You may be surprised to learn that crabs, snails, mussels, clams, oysters, sea stars, and worms are among some of the animal members of this "nutrient rich soup" called plankton. As larva, these animals floated from place to place, ate other plants and animals in this "soup", and grew until they "settled out" and developed into what we recognize as a crab, a snail, a mussel, a clam, an oyster, a starfish, or a worm.

Kachemak Bay can support a rich population of plankton because of the upwelling of nutrients from both Cook Inlet and the Bay. Upwelling means that nutrients from the bottom of a body of water are brought to the surface of the water. This phenomemon is accomplished by a combination of dominant winds in the area blowing the surface water and the Coriolis effect. The Coriolis effect deflects water to the right in the northern hemisphere, causing additional surface water to move offshore. Simultaneously, the colder water from the bottom containing nutrients, rises to replace this "moved" surface water. These nutrients are then carried by the currents up Cook Inlet where they meet the currents flowing out of Kachemak Bay. When the two currents meet, a circular current galled a gyre is formed. The nutrients now become heavily concentrated as they move in this spiral. Some of the water containing the concentrated nutrients spins out of the gyre and into Kachemak Bay. There are 3 gyres in Cook Inlet near Kachemak Bay and 2 gyres in Kachemak Bay itself.

WHAT DOES PLANKTON LOOK LIKE?

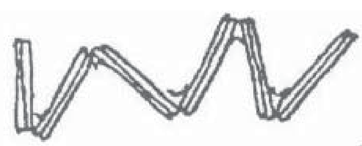
A person should be able to get a sample of plankton from an area like Kachemak Bay any time throughout the year. April and May, however, are usually the best months to see great numbers of plankton in the water. This is because the winter snows are beginning to melt and run into the bay. As these waters move across the soil in the forests, they pick up nutrients and deposit them in the bay. These nutrients are sort of like vitamins and minerals for the organisms living in the marine environment. The incoming fresh water also stirs up decaying material on the bottom of the bay where it enters. This decaying material also contains special nutrients for the marine organisms. Then, the gyres, currents and wind help to spread all these nutrients throughout the bay.

To get a sample of plankton some people use a special instrument called a plankton tow. This instrument is lowered into the water to a special depth and then dragged through the water for several minutes. The instrument is then brought back on board and labeled, telling at what latitude and longitude the sample was taken, at what depth it was taken, the date the sample was taken and what the weather conditions were when the sample was taken. People can then place a drop of the plankton sample on a microscope slide and view what was collected under a microscope.

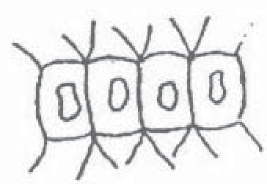


Plankton Tow

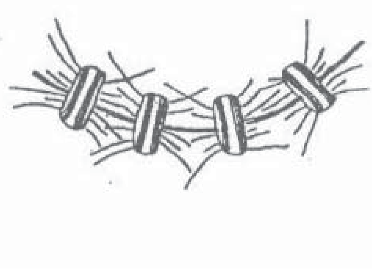
These are examples of some of the phytoplankton you will see under the microscope. Plants, or phytoplankton, are usually seen in long chains, like round or square beads on a necklace. They can be either yellow-gold or green in color.



Thalassiosira nitzschioides

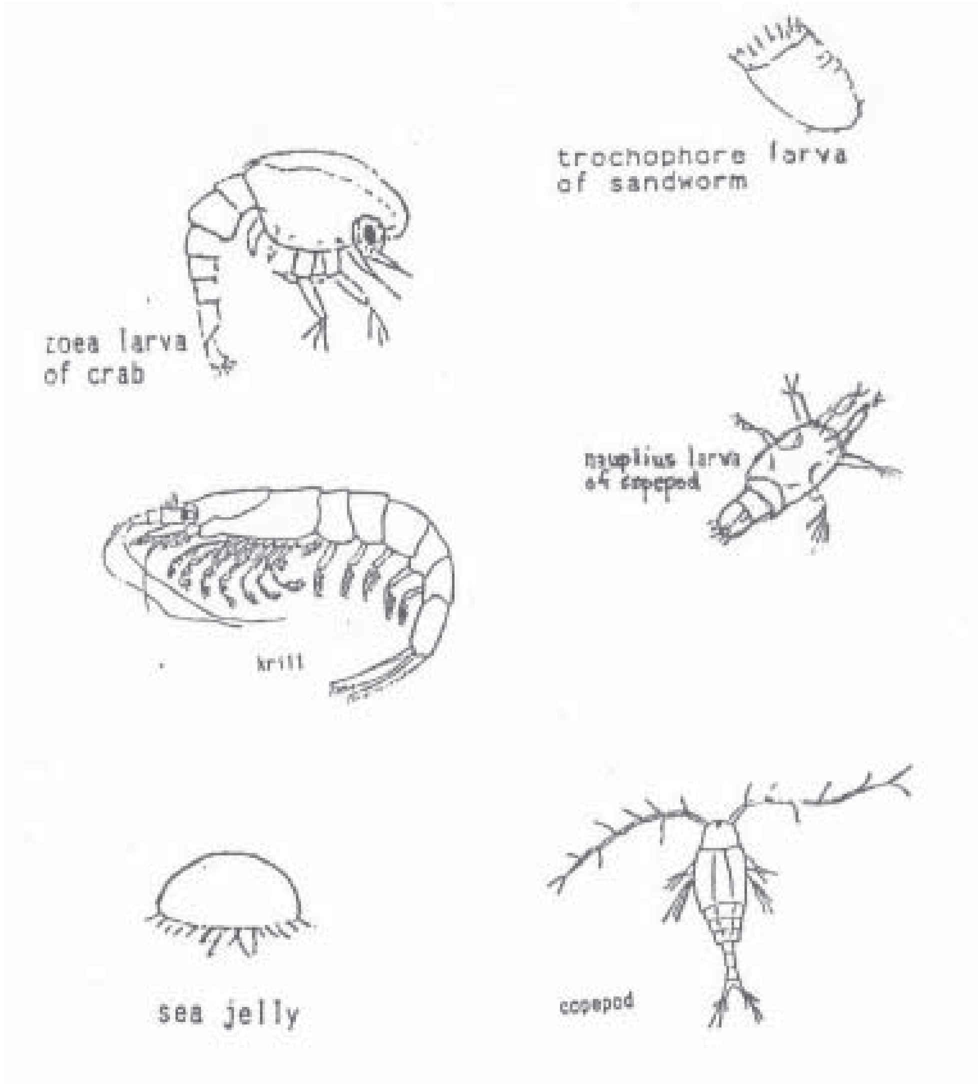


Chaetocerus sp



Thalassiosira aestivalis

These are examples of some of the zooplankton you may see under the microscope. Animals usually have appendages, like antenna, legs and arms, that move. Most of the animals are transparent in color.



There are usually people, charts and books available to help you identify the organism as either a plant or an animal. Sometimes it is possible to match what you see under the microscope with a picture and a name from a chart or a book.

WHY IS PLANKTON IMPORTANT?

Plankton IS THE FOOD for animals in the salt water. The phytoplankton, or microscopic plants, use the energy from the sun, carbon dioxide from the animals in the sea, and the chlorophyll in their cells to make food. This process is called photosynthesis. It is the same process that plants living on land use to create food. Then the microscopic animals eat these microscopic plants or other microscopic animals. Bigger animals, like herring, salmon fry, clams and oysters eat these microscopic animals and plants. Even bigger animals, like sea stars, crabs, and snails eat the “big” animals and so on.

If the plankton did not exist, there would be no food for the other animals in our marine environment. If there is no food for marine animals, like crabs, snails, sea stars, oysters, fish, whales, these animals will die.

What causes the number of organisms in this "soup called plankton" to increase in numbers? A warmer temperature of the water, the amount of clean water, the amount of sunlight, and the amount of nutrients and food in the water help the plankton to grow and to reproduce.

Knowledge about plankton (i.e. what it is, what kind of organisms make up plankton, what causes plankton to grow and increase in numbers, how much plankton exists in Kachemak Bay, and what kind of organisms eat plankton) is important information to know for the CLASS MISSION. Oysters eat plankton. If there is no plankton to eat, the oysters in the oyster farm will die.

WAHT IS A FOOD WEB?

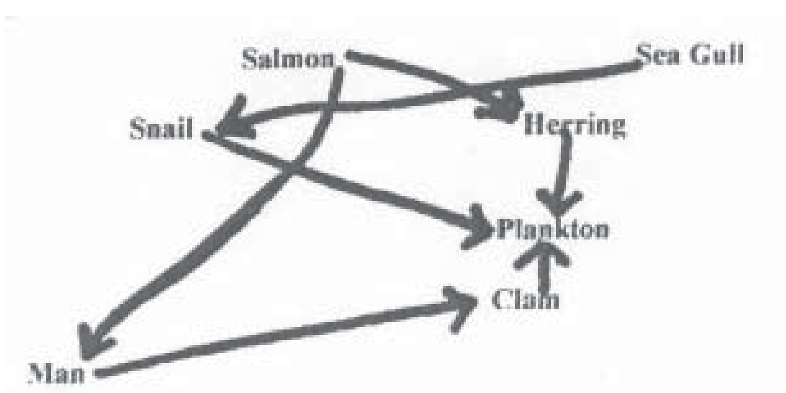
A food web looks like a spider web. Each thread of the web represents a food chain which shows the feeding relationship between particular plants and animals. A food web, therefore, will show the feeding relationship between many plants and animals in a particular environment.

One example of a food chain in Kachemak Bay is:
Plankton < Snail < Sea Gull.

A second example of a food chain in Kachemak Bay is:
Plankton < Herring < Salmon < Bear.

A third example of a food chain in Kachemak Bay is:
Plankton < Clam < Man.

When all three food chains are combined they will form a design similar to a spider web, like this:

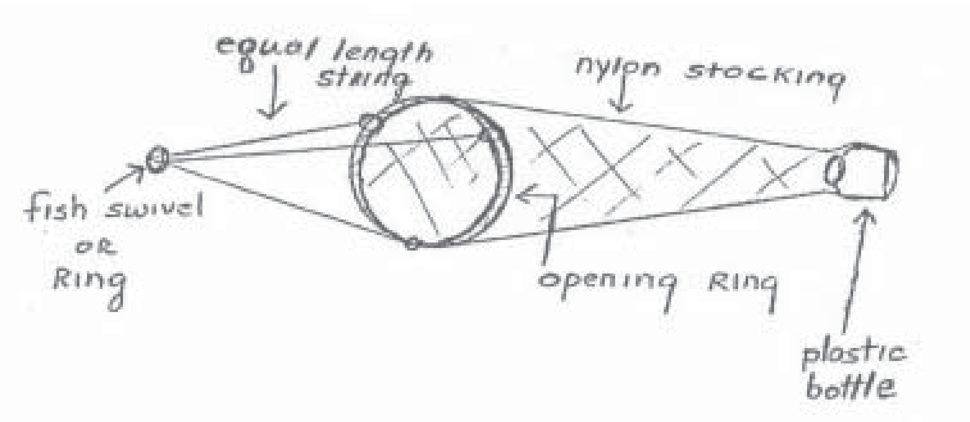


(Food chains are always written in a line. The first organism in a food chain is always a plant. An animal that will eat the plant is next in the line. An arrow is placed between the plant and the animal. The arrow must point toward the plant. This means that the animal eats the plant. A second animal that will eat the first animal can be placed next on the line. An arrow that is between the two animals and pointing to the first animal, means that the second animal eats the first animal. A food chain may contain any number of animals, but only one plant.)

HOW TO MAKE A PLANKTON TOW

Suggested Equipment:

- nylon stocking (panty hose will also work)
- 3 to 4 inch bottle (glass will break, so plastic is better)
- 3 equal length of heavy string (about 18 inches)
- a fish swivel or a small diameter ring (like a ring on a key chain or a cafe curtain ring)
- heavy thread or fish line on a large eyed needle to secure the nylon stocking to the opening ring
- "opening ring" (a 2 inch ring cut from a plastic bleach bottle, an embroidery hoop, or a coat hanger shaped into a circle big enough for the stocking to slip over).

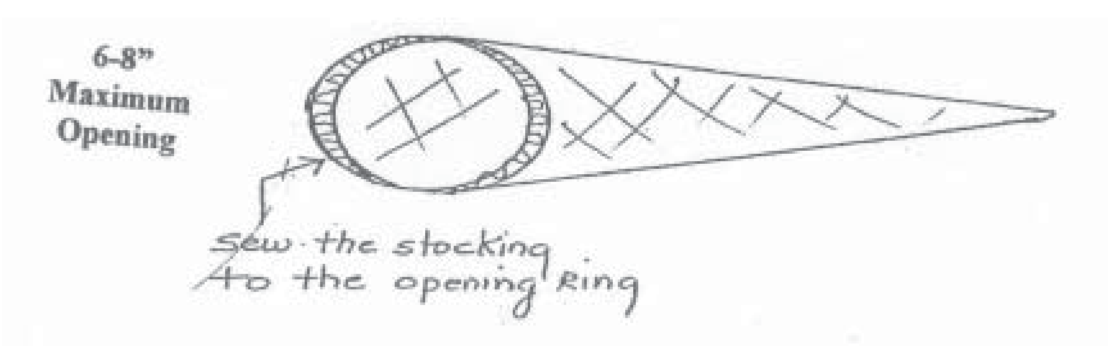


1. Study the diagram of a plankton tow to locate all the "suggested" materials and how they go together for the final product.

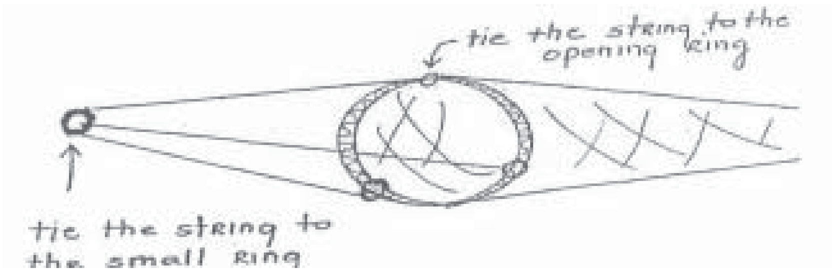
2. Make an "opening ring" by cutting a 2 inch ring from the middle of a plastic bleach bottle. Or shape a coat hanger into a ring that the nylon stocking will fit over. Or use an embroidery hoop.

3. Roll the "mouth" of the nylon stocking several times around the "opening ring".

4. Sew the top of the nylon stocking to the "opening ring" with string or heavy thread.



5. Tie the 3 equal length pieces of string to the “opening ring”.



6. Attach the loose end of the 3 strings to a fish swivel or a smaller ring (like a key ring).

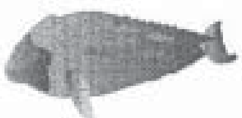
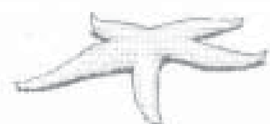
7. Insert the open bottle into the nylon

1

OYSTERS IN THE KACHEMAK BAY FOODWEB

MARINE WATCH

DIRECTIONS: "OCEAN" is played like Bingo. The "things" listed on this chart may affect the ability of oysters to live and grow. <u>WHEN YOU SEE AN ITEM LISTED ON THE CHART, DISCUSS HOW AND WHY IT COULD AFFECT THE OYSTERS OR THE OYSTER FARM.</u> Then mark an "X" through the term on the chart. WHEN YOU HAVE COMPLETED A LINE, VERTICALLY OR HORIZONTALLY, SHOUT OUT, "OCEAN!" Have your chart officially checked by the TRIP COORDINATOR to receive an OCEAN stamp. This activity will continue throughout the day, <u>so you may earn several stamps.</u>

 WHALE	FISHING BOAT	VOLCANO	FLOATING GARBAGE
SEA OTTER	NAVIGATIONAL AIDS	FLOATING LOG	SKIFF
GLACIER	GLAUCOUS WINGED GULL	SEAWEED	 SEA STAR
FUEL DOCK	TUGBOAT	BUOY	TANNER CRAB
FREIGHTER	SEAL 	EROSION	SEABIRD ROOKERY

2

IN THE HELM

WHILE THE PLANKTON TOW IS OCCURRING:

Follow directions #1, #2 and #3. ⇨

HELM ACTIVITY

#1. *Circle the side of the Bay the tow is conducted on:*

NORTH SIDE   SOUTH SIDE

#2. ***WRITE DOWN THE BEGINNING LATITUDE AND LONGITUDE***

LAT.______________________________

LONG.______________________________

#3. ***AFTER 5 MINUTES, WRITE DOWN THE ENDING LATITUDE AND LONGITUDE***

LAT.______________________________

LONG.______________________________

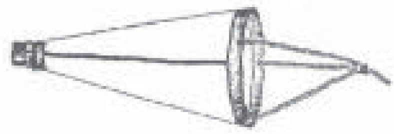
IN THE HELM OR BACK IN THE CLASSROOM

#4. ***In the chart below, draw a line to connect each piece if boat equipment with its correct function.***

BOAT EQUIPMENT	FUNCTION
1. Compass	a. An instrument that tells how much water is under the boat.
2. Depth finder	b. An instrument that helps the boat captain communicate with people on shore and on other boats.
3. GPS (global positioning system)	c. This instrument helps the captain "see" where the land is and how far away it is.
4. Loran	d. This instrument tells the latitude and the longitude of the boat by receiving signals from a triangulation of satellites in the sky.
5. Nautical chart	e. This instrument tells the latitude and the longitude of the boat by receiving signals from land based stations.
6. Radar	f. This is a "special map" used by mariners.
7. Radio	g. This instrument shows the <u>heading</u> the boat is traveling.

3

OYSTERS IN THE KACHEMAK BAY FOOD WEB
PLANKTON TOW ACTIVITY



1. *Circle the plankton tow you are doing:*

NORTH SIDE **SOUTH SIDE**

2. *Write down the latitude and longitude of your plankton tow*

______________________________________ **Beginning**

______________________________________ **End**

3. *Circle today's weather conditions:*

SUNNY **RAINY** **CLOUDY** **FOGGY** **WINDY**

4. *Complete the following chart:*

	Tow 1	Tow 2	Tow 3
Depth of tow			
Which of these words describes your sample? a) Clear b) Milky c) Dirty d) Green			
Can see small Organisms in the sample? Yes or No?			

*If you were an oyster, where would you find more food?*__________________

4

WATER SAMPLING ACTIVITY

DIRECTIONS: **Read question one and circle your answer. Then following the example, record the data from the water sampling activity on the following chart.**

1. *Circle the location in Kachemak Bay where you are sampling the water:*

NORTH SIDE **SOUTH SIDE**

2. *Fill out the chart below for each of your samples:*

SAMPLE #	DEPTH (Feet)	TEMPERATURE		DENSITY		SALINITY (0/00) (CHART)
		AIR	WATER	SEA WATER TESTER (g/cm)	CORRECTED DENSITY (CHART) (g/cm)	
EXAMPLE:	5 feet	12° C	7° C	1.021 g/cm	1.020 g/cm	27 0/00
1	10 feet					
2	15 feet					

REMEMBER!!

Oysters prefer:
a salinity of 25-27 0/00
a temperature of . . . . . 5-9 degrees C
lots of phytoplankton and zooplankton to eat
lots of clean sea water

The salinity of ocean water = 35%

The salinity of fresh water = 0

OYSTERS IN THE KACHEMAK BAY FOOD WEB

5a

SECCHI DISK ACTIVITY

Distance #1:

Record the distance between the marker at the edge of boat rail and the secchi disk:

________________ feet

Distance #2:

Record the distance between the marker at the edge of the boat rail and the marker at the surface of the water: **________________ feet**

Distance #3:

Subtract Distance #2 from Distance #1 **________________ feet**

(This is the limit of transparency or the the turbidity measurement)

Distance #3 is the turbidity measurement, the depth where sunlight no longer penetrates and is reflected back to your eyes.

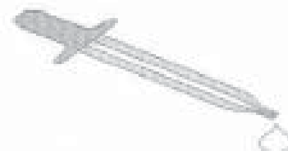
Distance #4:

Look at the graph that relates the turbidity depth for your eyes to the depth to which sunlight can penetrate and provide enoughsunlight energy for photosynthesis. What is the lowest depth that you can expect to find phytoplankton? **________________ feet**

WHY IS IT IMPORTANT TO KNOW THE TURBIDITY MEAUREMENT?

5b

OYSTERS IN THE KACHEMAK BAY FOODWEB



pH ACTIVITY

DIRECTIONS FOR pH: Oysters cannot live in water that has too much acid in it or that is too alkaline (base). Test each of the samples in the kit with the pH paper. Record the information on the chart below. **BE SURE TO RECORD WHETHER THE SALT WATER SAMPLE IS FROM THE NORTH SIDE OR FROM THE SOUTH SIDE OF KACHEMAK BAY.**

SUBSTANCE	IS IT AN ACID OR A BASE?	WHAT IS ITS pH READING?
1. salt water (north or south?)		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

OYSTERS IN THE KACHEMAK BAY FOODWEB

6

CHARTS, TIDES, AND CURRENTS ACTIVITY

DIRECTIONS:
#1. TIDES. Use the Seldovia tide table to answer the following questions.

1. *What is the highest tide during the month of May in Kachemak Bay?*______________________

2. *What is the lowest tide during the month of May in Kachemak Bay?*______________________

3. *Convert the answer to question #2 to a positive number and add it to thE answer to question #1. This is the TIDAL RANGE of Kachemak Bay.*______________________

DIRECTIONS:
#2. CHARTS. Use the Kachemak Bay chart to answer the following questions.

1. *What is the longitude and the latitude of:*
   a. **The Homer boat harbor** ______________________________________ **Long.**

   ______________________________________ **Lat.**

   b. **The dock in Peterson Bay**______________________________________ **Long.**

   ______________________________________ **Lat.**

   c. **Gull Island** ______________________________________ **Long.**

   ______________________________________ **Lat.**

2. *What information on the nautical chart is helpful in deciding whether to put an oyster farm on the north side or the south side of the bay? Answer this question by completing the following chart:*

HELPFUL CHART INFORMATION	WHY IS IT HELPFUL?

7

GULL ISLAND ACTIVITY

DIRECTIONS: Place a checkmark next to the birds that you see at Gull Island.

_____ Black-legged Kittiwake

_____ Common Murre

_____ Pelagic Cormorant

_____ Red-faced Cormorant

_____ Pigeon Guillemot

_____ Adult Bald Eagle

_____ Juvenile (young) Bald Eagle

_____ Northwestern Crow

_____ Glaucous-winged Gull

_____ Scoter

_____ Horned Puffin

_____ Tufted Puffin

8

WHERE WILL THE OYSTER FARM BE LOCATED?

OYSTER FARM ACTIVITY

DIRECTIONS: In the classroom, you will write 5 questions regarding oysters and oyster farming that you want to have answered by an oyster farmer. While the oyster farmer is talking, on the boat trip, listen for the answer to your question. When you hear the answer, write it down under your question. If you do not hear the answer, you should raise your hand. When the oyster farmer calls on you, ask your question. Listen to the oyster farmer's answer, and THEN write down the answer under the question on your paper.

QUESTION 1

____

____

ANSWER ______________________________________

____

____

QUESTION 2

____

____

ANSWER ______________________________________

____

____

QUESTION 3

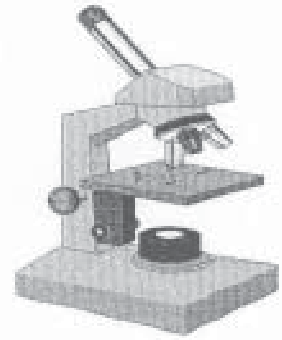
____

____

ANSWER ______________________________________

____

OYSTERS IN THE KACHEMAK BAY FOODWEB
MICROSCOPE ACTIVITY



DIRECTIONS:

1. **Prepare slides from a plankton tow container. Look at them under the microscope.**

2. **Fill out the table below for your slides.**

3. **Draw pictures of two organisms on each slide in the spaces and label it a plant or an animal. Identify it if you can from the posters of common plankton in Kachemak Bay.**

	Slide #1	Slide #2	Slide #3	Slide #4	Slide #5
From north or south side?					
Did you see plankton - yes or no?					
Did you see plants, animals, or both?					
Did you see lots, some, or a few plankton?					
Draw one plant or animal that you see and label it.					
Draw one plant or animal that you see and label it.					

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School________________________ Date____________

Location #1: Latitude____________________ Longitude________________________
Bait: Soak Time:

Location #2: Latitude____________________ Longitude________________________
Bait: Soak Time:

	Location #1 Tanner Crabs	Location #1 Dungeness Crabs	Location #2 Tanner Crabs	Location #2 Tanner Crabs
Males				
3, 3 ¼				
3 ½, 3 ¾				
4, 4 ¼				
4 ½, 4 ¾				
5, 5 ¼				
5 ½, 5 ¾				
6, 6 ¼				
6 ½, 6 ¾				
7 or more				
Females				
3, 3 ¼				
3 ½, 3 ¾				
4, 4 ¼				
4 ½, 4 ¾				
5, 5 ¼				
5 ½, 5 ¾				
6, 6 ¼				
6 ½, 6 ¾				
7 or more				
Other Species				

Kachemak Bay
Onboard Oceanography

Information for Chaperones

Welcome Aboard!

The Center for Alaskan Coastal Studies and the crew of the Rainbow Connection welcome your participation in this exciting learning experience!

During todays excursion, students will participate in a series of hands-on activities and scientific experiments to collect data to help them complete a mission. If at any time you feel you can assist the CACS volunteers with any of the activities, please speak up and let them know. This experience is not only for the students to learn but for you as well.

Here is what you, as a chaperone, can do to help the students get the most out of their cruise:

→ Ensure that your group moves to the next activity and that students stay with your group.

→ Keep track of the data sheets and pencil for your group.

→ Ensure that the students follow the rules of the boat.

→ Watch students carefully - they will need to hold on in rough seas. Make sure they are dressed appropriately for the weather when outside the boat cabin - coats, hats, gloves, rainjackets.

→ Keep students focused on the activities and assist teachers with discipline. (Crew members and CACS staff and volunteers will be busy with the boat and instruction, so discipline is the job of the teacher and chaperones.)

Thank you!