ANSWERS TO KEY QUESTIONS BY LESSON NUMBER

LESSON 1

*Our website is updated periodically. Before using these questions with a class, check them out for updates.

1) Click to "Mission" in "About Us". In what 3 ways does DEI hope to improve the quality of life for people of downeast and coastal Maine?

DEI hopes to improve the quality of life for the people of downeast and coastal Maine through applied marine research, technology transfer, and public marine resource education.

2) Click on "History" in "About Us". In 1987, in the town of ___Beals _____ in ___Washington_____county in __Maine____(state), Dr. Brian Beal became involved with local__clammers_____and __town officials_____who were concerned about the declines in clam harvests.

3) Located on Perio Point, Beals, Maine, BIRSH stood for __Beals Island Regional Shellfish Hatchery_____ and

was the first public _shellfish hatchery_

4) Over the next 16 years, hundreds of millions of clams were raised for __40_towns.

5) List 3 technical processes of clam production that were developed at BIRSCH.

Three technical processes of clam production that were developed at BIRSH were growing clams, overwintering clams, and seeding clam flats.

6) Scroll down through the photos in "History". Briefly describe DEI's (formerly BIRSH) present location and facility.

There are many acceptable answers. DEI is located on Black Duck Cove on Beals, Maine. The facility is located on 8.5 acres of land with 2000feet of deep-water frontage. The facility has a shellfish hatchery, seawater and freshwater laboratory, and marine education center. There are plans to expand in the future. Currently a new pier is under construction.

7) Click **to "Current Pier Project" in "About Us".** The replacement pier will measure _30__feet by _100_feet and is constructed of 100% __fiber composite. At extreme low tide, there will be a water depth of __10__feet.

8) **Click to "Staff" in "About Us".** Staff members at DEI include: Staff members at DEI are: Dr. Phil Yund, Dr. Brian Beal, George Protopopescu, Kyle Pepperman, and Cody Jourdet.

9) Click to "Our Senior Scientist", name is ___Dr. Phil Yund__whose research is in _marine ecology and fisheries ecology__.

10) DEI is affiliated with a local college, _ University of Maine at Machias _, which has its Marine Field Station at Black Duck Cove.

11) **Click to "Board of Directors".** List one of them. Several choices are available.

12) **Click on "DEI's Future".** Why does DEI plan to add marine research laboratory? Dormitory and dining hall?

DEI plans to add a fully equipped marine research laboratory for local fisherman, marine entrepreneurs, marine scientists, and students to use. A dormitory and dining hall is planned for longer stays.

13) **Click on "Summer Employment"**. What employment opportunities are available for this year? Two positions for undergraduate students are available at this time; One in the study of the growth rates and survival of two species of blue mussels; one in the study of the coastal circulation around Great Wass Island.

14) Click on "Current Research". Briefly describe one of the current research projects at DEI. Use the back of this page.

DEI is growing soft shell clam for introduction into the wild environment at various locations, using many techniques for survival; DEI, with the help of local fishermen, is moving wild scallops into closed areas to see if the scallops will survive and grow; DEI is working with a local clammer in a farming project using hard shell clams; DEI is involved in a lobster project using tidal pounds to grow young lobsters; DEI has successfully brought these clams from the Gulf of St. Lawrence to the lab to examine the fate and growth of this raw sushi delicacy, popular for its red-colored foot

SOFT SHELL CLAMS – For the past 20 years, DEI has produced and continues to produce seed clams for shellfish conservation committees in Maine, New Hampshire, Massachusetts, and Eastern Canada. DEI continues to be involved in experiments and research with soft-shell clams, completing projects with Edmunds, Stockton Springs, and Hampton Harbor, New Hampshire.

SCALLOPS – In conjunction with Jonesport and Beals fishermen, Maine DMR, and the University of Maine Sea Grant Extension, DEI is involved in a project that has two main concentrations: 1) moving scallops into areas currently closed to digging as an attempt to bring back a once lucrative industry 2) collecting wild scallop spat (seed) using collectors that have been tried in Canada, Chile, and Japan. The project is funded by the Northeast Consortium (UNH, UM, MIT, and Wood's Hole)

HARD CLAMS – *Mercenaria mercenaria*-DEI is working with Mr. Joseph Porada in a clam-farming project on lease sites in Goose Cove. With funding from the Maine Technology Institute, DEI successfully spawned adult hard clams using brood stock collected in Trenton. Employing many techniques similar to those used in rearing soft-shell clams, DEI raised, over wintered, and seeded the hard clams at Goose Cove. Dr. Beal and the staff will continue to work with Mr. Porada.

LOBSTERS – Working under a grant from Maine DMR, DEI is trying to determine how fast lobsters grow and whether their growth is influenced by the region or substrate on which they settle. Cages of juvenile lobsters were deployed at York, Boothbay, Tenants Harbor, Stonington, Beals, and Cutler. Two measures of aging will be taken.

With funding from the Washington County Fund of the Maine Community Foundation, a second study is the feasibility of raising lobsters in tidal pounds for stock enhancement purposes. Dr. Beal and Dr. Robert Bayer, Director of the Lobster Institute at UM will hatch and rear lobsters. The effort is aimed at discovering alternatives if Maine's lobster fishery should suffer a decline.

15) **Click on "Published Research". List one research topic. (**Your teacher may have you read and summarize the findings of one of the published articles.) If the instructor wishes, this question can be completed in Lesson 19.

Published Research on DEI website (by DEI staff members as of 2-8-11)

USE WITH LESSON 1 AND LESSON 19

DEI staff members have several published projects. More information can be found on the website at www.downeastinstitute.org under "Published Research". The summaries presented here give a very brief synopsis of other avenues of research pursued by staff members at DEI and elsewhere.

Beal, B.F.; Bayer, R.; Kraus, M. G.; Chapman, S.R.

1999. A unique shell marker in juvenile, hatchery-reared individuals of the soft-shell clam, *Mya arenaria* L., Fishery Bulletin 97(2), 380-386.

Hatchery- reared clams that have been placed in a flat and collected at a later date have a distinct shell marking that shows its initial length at placement.

Beal, B.F.

1983. Predation of juveniles of the hard clam, *Mercenaria mercenaria* (Linne) by the snapping shrimp *Alpheus heterochaelis Say* and *Alpheus normanni.*

Summary of a study that showed 2 species of snapping shrimp crushed and consumed clams in a lab setting; the results imply that previous studies on blue crab predation may have overestimated crab predation, as the shell damage to the clam is the same.

Kraus, M.G.; Beal, B.F.; McMartin, L.

1992. A comparison of growth rates in the ocean quahog, *Artica islandica* (Linnaeus, 1767) between field and laboratory populations shows the potential of culturing them in shallow water sites protected from predators.

Vadas, R.L.; Beal, B.F.

1987. Green algal ropes, a novel estuarine phenomenon in the Gulf of Maine, embedded itself in the substrate. The authors who observed this discussed the possible negative effects on bivalves.

Beal, B.F.; Parker, M.R.; Vencile, K.W.

2001. A study on the survival and growth of juvenile soft shell clams was done to discover if competition or predation is more important in regulating populations of soft shell clams in a particular area. Predation seemed to be the more important factor in this study.

Beal, B.F.; Lithgow, C.D.; Shaw, D.P.; Renshaw, S.; Ouellette, D.

1995. Over-wintering hatchery-reared clams by suspending them mesh bags in a makeshift shelving unit made of lobster trap wire, reduced clam mortality compared to juveniles placed in the flat during a seeding in the fall season.

Beal, B.F.

2002. Small scale field impoundments of soft-shell clams, *Mya arenaria*, were successfully completed, to hold clams over a period of time until commercial value increased.

Beal, B.F.; Kraus, M.G.

2002. A yearlong study was done on the interactive effects of initial size, stocking density, and type of predator deterrent netting on the survival and growth of cultured juveniles of the soft-shell clam *Mya arenaria*, some protected by netting from predation and some not. Protected clams had a higher survival rate; growth was about 18 mm; results seem to show that juveniles of 8-10 mm could be planted as suggested in the study and then in the late fall season remove the net and let nature take its course. It would take 2 to 4 years to grow the clams to the legal size depending on location and seawater temperature.

Beal, B.F.; Mercer, J.P.; O'Conghaile, A.

2002. The survival rate of hatchery-reared European lobster, *Homarus gammaues (L)* in field-based nursery cages on the Irish West Coast. Reported on www.sciencedirect.com, and summarizes the study or raising Stage XII juvenile lobsters at a low cost, low maintenance method. Results indicate this is an option.

Beal, B.F.; Vencile, K.W.

2001. In a collaboration between clam (*Mya arenaria*) harvesters and bloodworm (*Glycera dibranchiata Ehlers*) diggers, a plot was seeded and monitored to see what effects digging had on the juvenile clams. Predation by horseshoe crab and milky ribbon worm was high, but blood worming did not have a high effect on the mortality of juvenile clams. Bloodworms are shallow burrowers and diggers did not disturb Mya when digging for bloodworms; digging for clams, on the other hand, had a high effect on the mortality of the juveniles.

Beal, B.F.; Chapman, S.R.

2001. Methods for rearing stages I-IV larvae of the American lobster (*Homarus americanus)*. Five experiments were conducted using methods similar to those used in Cutler, Maine. Mortality/survival depended on: getting stage I larvae immediately after release from the female, bubbling the sea water the larvae are kept in to keep them from "eating" each other, and overfeeding them with enriched *Artemia* (brine shrimp)

Beal, B.F.; Chapman, S.R.; Irvine, C.; Bayer, R.C.

1998. A community-based fishermen –sponsored public stock enhancement program. Lobster fishermen voted and Legislature approved a portion of fisherman's fees to go into a fund for stock enhancement. A hatchery was created in Cutler to raise 175,000 lobsters to stage IV and V, each year from 1986-1991. With no means to hold the lobsters to a larger size and tag them, the hatchery developed a "blue" lobster strain so tagging wasn't necessary. Behavior of blue lobsters seemed to be the same as normal.

Vadas, Sr., R.L.; Beal, B.; Dowling T.; Fegley, J.C.

1999. Experimental field tests were conducted in which green sea urchins (*Strongylocentrotus droebachiensis*) were fed a different algal diet to see if it would make a difference in the urchin roe (gonads). Results showed that it would be possible to enhance the sea urchin diet to meet the demand for roe during an off-season.

Beal, B.F.

2006. A study on *Mya arenaria* to see if density affected growth and survival was conducted at the same time the study was also testing for predation in two different bays at 4 orders of magnitude: embayments, sites within embayments, tidal gradients, and blocks that varied in their proximity to each other. Evidence suggests that predation is the dominant factor controlling clam abundance and distribution patterns in the intertidal zone.

Beal, B.F.

2006. A series of experiments was conducted from 1986 to 2003 to see what biotic and abiotic factors influenced the growth of wild and cultured clams (*Mya arenaria*). A series of experiments was conducted that included: moving clams from slow growing areas to other areas for faster growth, studying the effects of tidal height on wild and cultured clams, studying the effects of spatial variation on cultured clam growth, studying the growth and dispersion of cultured clams in experimental units, studying the effects of Euspira heros Say (moon snail) on wild and cultured clams, and studying the species composition of the crustacean predators that forage intertidally. Protective netting (4.2mm openings) increased the survival rate; clams that survived grew slowly at the low tidal mark, but predation by moon snail was high; both green crabs and rock crabs produce the crushing and chipping of clam shells.

Beal, B.F.; Protopopescu, G.; Yeatts, K.; Porada, J.

2009. Experimental field trials on the nursery culture, overwintering, and field grow-out of hatchery reared northern quahogs (hard clam), *Mercenaria mercenaria (L)* in eastern Maine. Information is provided on the processes used and the growth and survival rates. Hard clam farming may help diversify the wild shellfish industry.

16) List the names and contact information for two people if you needed more information. Brian Beal at bbeal@maine.edu or George Protopopescu at 497-5769

17) Click on NSF. Briefly describe the project made possible by support from the National Science Foundation. Be sure to look at the student photos in this section.

With funding from NSF, DEI has constructed an educational center, developed a marine science curriculum, hosted workshops for educators and students, and helped arrange a Marine Science Fair for local schools involved in a DEI clam project. This summer of 2012, DEI plans to host a summer day camp for students. It has hosted two prior day camps for local schools.

18) **Click on Directions**. Print this page to make sure you know how to find us for your visit to DEI.

LESSON 2

Key Questions

- Where will we travel to place the clams once we have finished preparing them?

We will travel to a section of mud flats in your community that we have asked the town officials about using for our project

- Why will we put clam containers at upper, middle, and low tidal zones?

We want to find out if there is a difference between how fast clams grow in one area or the other, and we want to find out if they survive in one area over the other.

- What will we cover the clam containers with to protect the clams from predators?

We will put mesh netting over some of the containers to protect them from predators.

- Why will we leave some containers of clams unprotected?

We want to find out if the protective netting makes a higher survival rate

- Why do we need to keep track of where we put each clam container?

We will keep track of each container, so that we can tell what area showed a better growth rate and what are showed a better survival rate.

- Why will we use plastic containers instead of the type we could make out of newspaper?

The containers will be exposed to weathering and water for several months. A newspaper container would not survive for that long and we could not tell what happened to the clams that were placed in it.

- What do you think will happen to the clam containers? Why?

Accept various responses for this question. Some will think that the containers will be there in the fall, others will think they will be gone; Why? Some will think the containers will be destroyed by weathering

and water or predators in the area (human or animal); Some will think clams will grow, others will think they will die

- What do you predict will happen to the clams that are planted in protected and unprotected plastic containers at the upper, middle, and lower intertidal?

This section is meant to be their predictions to the hypothesis. Their prediction should be written down to be given to DEI (Instructors may submit copies of the student work instead of the originals)

LESSON 3

The following questions were asked as a review of Lesson 2

- "Why is harvesting and consuming clams important to us?

The harvesting and consumption of soft shell clams, *Mya arenaria*, has been important to our area since Native Americans lived here in the summers many years ago. Over the years, we realized that selling clams could be a financial resource for our area, and we expanded the industry to include that aspect.

- "How can the DEI Clam project help this industry?

Over the years, harvesting and selling clams has developed into a lucrative income for many local people and we have the chance to help the industry grow and thrive through the DEI Clam project.

Key Questions for LESSON 2 and 3 answers are in LESSON 2

- What discoveries, if any, did we make at the upper, middle, and lower tidal zones? (For LESSONS 4 and 5) OR

Journal Entry - Students may add their responses here about their trip to the tidal flat. Many students have never been in this habitat. Allow them to discuss what it was like to walk in the mud. Allow them to explain how the containers were placed and marked. Have them recall their trip as an oral group discussion or a journal entry. They may talk about things they experienced with their senses. What did they see? Hear? Taste? Touch? Smell?

LESSON 4

Key Questions

Depending on the length of time given to this lesson, the first few questions give the students a chance to speculate as to what will happen, when they gather their clam containers. The answers here represent a description of some scenarios that have been documented in similar studies and may/may not accurately describe what the students find this time.

- What can we expect?

We can expect many varying results. Many clams will not have survived, but many clams will have survived and grown. Some clam containers will have no clams in them. Other wild clams may have entered the containers. Predators may also have entered the containers, such as green crabs, moon snails, and worms. Netted containers show a higher survival rate based on other studies.

- Will we find all of the clam containers?

We hope we will but there are many reasons why we might not. Severe weather or erosion could have caused containers to move. Humans could have moved them. Usually containers are found, but they may have moved out of place.

- Will the nets be on all of the containers?

We do not know, but most of them have remained covered in other field experiments

- Will the containers be in the same place as we planted them?

We do not know, but most of them have been in other field experiments

- Will we find all of the containers from the high water mark? the middle tidal zone? the lower tidal zone?

We do not know, but most of them have been recovered in other field experiments.

- Will the clams from one area look the same as those from another area?

We do not know, some growth rates may be similar, others may be more or less.

- Will the clams still be in the containers?

This will depend upon the survival rate for that container

- Will the clams be alive?

Some containers were empty, some containers had live clams and bits of shell, some containers had whole half shells with a drill hole

- What else (other organisms) will be in the containers?

Green crabs, marine worms, and moon snails were found in the containers.

- What did we find in the clam containers from the upper tidal zone? Why?
- What did we find in the clam containers from the middle tidal zone? Why?
- What did we find in the clam containers from the lower tidal zone? Why?

The students will find and document what is in each container. They may see some changes at the upper tidal zone because those containers are exposed more than the other two zones. They may see more growth in the containers at the low.

- Does our research point us to any general conclusions or statements from our plant containers?

- Usually, the clams in netted containers have a better survival rate regardless of what level they are at unless a predator got into the container . Clams at the low tide mark could show more growth, but they do not always. It seems that if they can survive, they will grow regardless of where they are on the level, but the resources of food for them can be different from area to area. Each tidal area is different concerning growth and survival, and the two statements are generalities under normal conditions.

LESSON 5

Key Questions

- What did we find in the clam containers from the upper tidal zone? Why?
- What did we find in the clam containers from the middle tidal zone? Why?
- What did we find in the clam containers from the lower tidal zone? Why?
- Does our research point us to any general conclusions or statements from our plant containers?

We found some live clams, some clam shells, some clams we did not put in the containers, some worms we did not put into the containers.

The following information represents the findings during an experiment with a K-8 school in 2012, and may be useful to the Instructor:

DEI's project with your students was based on the following hypothesis:

How does the place where juvenile clams, *Mya arenaria*, live on a flat (upper, mid, and lower tidal zone) affect how they grow and survive?

In summary, to test the hypothesis, this is what we did.

The field-based experiment consisted of four main parts:

- preparation of materials;
- planting/deploying the experiment;
- harvest/termination of field component; and,
- analysis.

Students prepared and placed the experimental units containing juvenile clams (ca. ½-inch, or 12 mm, in shell length) into the soft-bottom environment at high, middle, and low tidal zones. Approximately three months later, the units were excavated and their contents were inspected for living and dead clam individuals. An accurate count of surviving clams and a measure of each shell (for growth rate) was taken to collect data to answer the essential question/hypothesis.

After completion of the Clam Project with your students, there are key concepts for discussion using the data. Dr. Beal has organized the data for you in the format of

circles* representing the blocks where the clams were placed, and using crossed lines over the circles to represent the netted containers. As the students look at the graphs of protected and unprotected containers, try to have them focus on the following:

1. Do clams grow any better in netted (protected) vs. unnetted (unprotected) containers?

2. Do clams survive any better in netted (protected) vs. unnetted (unprotected) containers?

3. Do clams grow any better at the high vs. the mid vs. the low tidal zones?

4. Do clams survive any better at the high vs. the mid vs. the low tidal zones?

Depending on the age of your students, try to represent the answers to the questions. What may have caused a container to be empty of live clams? A green crab? A moon snail? Some other environmental occurrence? Some students found evidence of crushed shells which implied a green crab. Some students found perfectly round countersunk holes in the tiny shells which is the signature of the moon snail. Green crabs, moon snails, and sandworms were found in some netted and unnetted containers. Many of those containers had low survival rates. The students learned about the Hatchery Mark, and used it to measure their clams' initial lengths.

ASK THEM, NO ONE KNOWS BETTER THAN THEY DO, WHAT THEY MAY HAVE OBSERVED AND LEARNED FROM THE PROJECT.

The page of "circle" results Dr. Beal prepared for you does not give specific answers to what happened in the pot regarding survival. The information presented only gives a percentage. For example, if 5 clams out of 12 survived in a particular pot (41.7%), you don't know whether the rest of the clams were 1) missing; 2) dead with crushed shells; 3) dead with drilled shells; 4) dead with undamaged shells; or, 5) a combination of these categories.

Should you or your students want additional information about the fate of the clams in any particular unit, please e-mail Dr. Beal (bbeal@maine.edu) and he can help you with these questions. This information was recorded on each data sheet, and the data sheets are easily accessed.

Hopefully, this brief synopsis will help you with your students.

*The circles represented the containers. Dr. Beal put the data results in the circles.

LESSON 6

Key Questions

- What are the major predators of *Mya arenaria*?
- Can you list a characteristic of a predator?
- Can you state a common name and a binomial name for a predator? For any other living thing?

The answers are below:

Carcinus maenus	green crab	Notorious crustacean . . .;
Neanthes virens	sandworm	worm which can grow to great length . . .
Euspira heros	northern moon snail	gastropod . . . drills a hole near the umbo
Glycera dibranchiata	bloodworm	creamy reddish/pink worm . . .
Cerebratulus lacteus	milky ribbon worm	everts its proboscis into the clams siphon . . .
Anas rubripes	black duck	snips off the siphons of larger clams . . .
Fundulus heteroclitus	mummichog	hardy fish that eats clams . . .
Homarus americanus	American lobster	a large, edible marine crustacean . . .
Euspira triseriata	spotted moon snail	a gastropod that preys on clams in a similar way .
Cancer irroratus	rock crab	a crab with 9 marginal teeth on the carapace . . .

- How do these predators cause problems for the clam industry?

The predators cause problems for the industry because they are depleting many of the juvenile clams and commercial size clams. Harvests are shrinking.

- What might cause a species that was not a known predator of *Mya arenaria* to become one?

If a predator is in an area where it finds a good food source and other requirements for living, it will probably stay in the area.

- How can we use the process of elimination to make a scientific guess about a predator? How can we then prove or disprove that guess?

We can look at how the clam shell was damaged by the predator. If the clam is totally gone, we might assume a human or other animal dug it up/consumed it; Sometimes we cannot disprove our guess without further information

LESSON 7

Key Questions

- Are there any words on the list that you already know?

This would be a good point to assess what the students already know or remember from their marine science The Instructor can keep referring to the master vocabulary and definition lists.

- Can you tell me a word that you know after playing Clam-O? What does this word mean?

The responses here may vary. The Instructor could try to make note of a few words that students struggled with during the game, and prompt them or help to suggest words they did not know before, but do now.

LESSON 8

Key Questions

1. How can you tell the boy enjoyed being with his grandfather?

The boy says he "enjoyed getting up early" to be with his grandfather; he remembers many details; he has shared this story and throwing clamshells with many others

2. What was the name of the boat? How does the boy describe his grandfather's boat?

The boat was named the Seahorse. The boy describes it as a "typical Jonesport-style lobster boat built in 1935", "the oldest working boat in Jonesport", and the "slowest" working boat in Jonesport.

3. How do you know that other people besides the boy have made a "clam shell fly"?

The boy's grandfather says that his grandfather showed him "how to scale a clam" when he was a "youngster", the boy's grandfather says that he and his "school chums" used to have contests to see who could "scale" one that farthest; and the boy says he has "shown" many people over the years.

4. Has anyone in this class thrown shells? Can you remember who did this with you or told you how to do this?

(Students should have an opportunity to share memories of their own.)

5. Can you describe how to hold the clamshell before you throw it?

Hold the clam between the thumb and index finger; make sure the inside of the shell points up; hold the pointed end of the shell towards the index finger and the rounded end against the thumb.

LESSON 9 -11

Key Questions

- What does the clam do when it is placed in the sand?

The observation of moving through the sand will probably only be able to be seen if the Instructor is able to come up with some idea for observation, a clear container of some sort, with the clam fairly close to the side of the glass. The clam may not do anything for a few minutes, then the students may observe the foot come out and a slow movement downward or upward towards salt water.

- In the water?

If the clam is able to use the siphon to filter food from the water, it may not move, but the siphon may be observed to be extended a bit for taking in water.

- What parts of the clam can you see?

Umbo, hinge ligament, anterior end, posterior end, growth rings, stress rings, etc.

- Can you see the foot?

The opening for the foot is located nearly opposite from the siphons.

- The siphon(s)?

The black protrusion that can be seen even if the clam is retracted quite far into its shell

- What is the purpose of the excurrent siphon? Incurrent siphon?

The excurrent siphon is located on the hinge side of the clam. The incurrent or larger siphon is on the right. The siphons inside act like straws. The incurrent siphon draws water into the clam's body. The water has plankton in it, which is very small microscopic plant life that clams eat. The excurrent siphon expels waste. During reproduction, the excurrent siphon expels sperm and eggs.

- How does the clam use its foot to move?

The Instructor will explain that the clam may attempt to burrow into the sand using its foot, which is light colored. The students may see the foot change shape as it attempts to burrow into the sand. {The clam will press its foot into the sand, then blood enters the foot and causes it to swell and form a hatchet shaped anchor. The foot muscles will then contract and pull the clam down into the sand.

- How many clam parts can you name?

Student answers will vary, but may include Umbo, hinge ligament, anterior end, posterior end, growth rings, stress rings, the foot which is located nearly opposite from the siphons which are side by side in the black protrusion that can be seen even if the clam is retracted quite far into its shell, the excurrent or smaller siphon, the incurrent siphon or larger siphon.

- What happens when you touch the clam?

The handling of the clams will probably cause the siphons to retract.

LESSON 10

Key questions See LESSON 9 for the ANSWERS FOR THE FIRST QUESTIONS

What does the clam do when it is placed in the sand? in the water?

What parts of the clam can you see? Can you see the foot? the siphons?

What is the purpose of the incurrent siphon? excurrent siphon?

How does the clam use its foot to move?

How many clam parts can you name?

- Describe the main parts of the life cycle of the clam.

Important Life Cycle stages:

Sperm and eggs are released from the male and female clams (see life cycle diagram). Once sperm and eggs are released, they float around in the water. If they are able to come in contact with each other, fertilization occurs and cell division starts. The trocophore develops within 6 to 12 hours. Discuss the parts seen in the diagram. Within the next 24 to 36 hours, the veliger larva develops. In this stage, the larvae floats through the water and feeds on phytoplankton. In the wild, veligers are eaten by many fish species at this time. The length of this stage varies in the research from 10 days to 6 weeks, depending on the water temperature. Clams growing in a hatchery have controlled water temperatures, and their growth is more constant. As the veliger stage progresses, a foot is developed which the clam will use for burrowing. The byssal gland, which secretes a sticky thread called the byssus is used by the clam to anchor itself to the sand. The young clam can move from place to place attaching itself by the byssus, and testing the sand with its foot, until it finds a location that seems suitable. Then it will use its foot to burrow into the sand where it usually remains.

When it becomes an adult, in 1 to 2 years, the cycle of sperm and egg will begin again.

(Abraham, Barbara J., and Perian L. Dillon. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)". Fish and Wildlife Srvice U.S. Department of the Interior. (1986) 3-5.Print.

LESSON 11

Key Questions- answered in LESSON 9

What parts of the clam can you see? Can you see the foot? the siphons?

What is the purpose of the incurrent siphon? excurrent siphon?

How does the clam use its foot to move?

How many clam parts can you name?

LESSON 12

Key Questions

- What is a food chain?

The transfer of food energy from one organism to other organisms

- How is it different from a food web?

A food chain is one part of a complex system of interconnected food chains called a food web

- How is plankton important to the food web/chain?

Plankton, (Phyto and Zoo) - that are free floating drifters with their movements controlled by ocean tides and currents; an important food source in the marine food web.

- What is the difference between phytoplankton and zooplankton?

Microscopic plants makes up phytoplankton whereas microscopic animals makes up zooplankton.

- What is the difference between a consumer and a producer in a food chain?

A Consumer - an organism that gets food from eating other organisms whereas a producer - an organism that makes its own food from the energy of the sun,
such as phytoplankton-Producers form the base of the food web.

- How could a natural disaster, environmental disaster, or some other action/event upset the balance of the food web/chain?

There are many results from an upset to the environment. One or more food sources could be moved to another location, severely depleted or completely wiped out

- What does the regulation of a fishery attempt to do for a food chain?

It attempts to keep it in balance to protect one species from being wiped out or over producing in its environment. Too much of one species will put a strain on the organism it eats.

- How can we as individuals help to keep a food chain in balance?

Such responses as become informed about why regulations exist, protect species when we are in the environment, do not pollute, protect the environment, etc

- Where else do you observe food chains in your natural environment?

Students may say humans, animals in the forest, birds in the sky, etc. and they could be led to discussion of the points in the environment where one meets the other.

LESSON 13

Key Questions
Section 1

- What are some common sights of the marine habitat?

Depending on the type of marine habitat; tide pools, salt water, wave and wind action, sand, mud, various seaweeds and shore grasses, crabs, periwinkles, starfish, mussels, gulls, ducks and other shore birds, bits of shells, various sizes of rocks,barnacles, garbage and other pollutants; depending on whether it is high or low tide, boats, clam/worm/seaweed harvesters, etc.

- What are some common sounds of the marine habitat?

Gulls, sounds of water as it moves in an out with the tide, sounds of water hitting rocks, wind whistling, boat engines, etc.

- Describe what can be touched/felt at a marine habitat.

The mud, salt spray, hot sand, marine organisms (shells, slime, etc), water, etc.

- Describe what is smelled at a marine habitat.

Mud, salt water, decaying plant and animals at some locations, etc,

- Describe the marine habitat(s). Describe the marine habitat(s) that you visited.

If the students were able to go on a field trip to a particular marine habitat, have them describe what they saw. This could be done as a class activity during or after the field trip. Their descriptions could be written down or verbal. Use their descriptions as a basis for reviewing aspects of the habitat and trying to decide which type of habitat it was (physical or biogenic, etc)

The answer will depend on what habitat(s) the students visited it may be sandy, rocky shore, tidal flat,estuary, and water column (where there is always water)

Section II

- Where do clams live?

In the muddy or sandy substrate, except for when they are in their earlier life stages, floating in the water column before they attach to the substrate

- Where does the clam get food and water?

The soft-shell clam, *Mya arenaria,* is a filter feeder that takes in plankton through its incurrent siphon, as the tidal water rises and falls, Mya extends its siphons into the water.

- Where does the clam get shelter?

Mya arenaria is burrowed down in the tidal substrate. It seldom leaves the area that it chose as a tiny juvenile clam, unless the conditions of the habitat change or a predator moves it without destroying it.

- How does the clam stay safe?

Mya arenaria can retract its siphons and clamp its shell fairly tight.

- What are some other species that exist in this marine habitat?

Its predators-black ducks, moon snails, green crabs; shore birds, gulls, some raccoons and small wildlife may visit; seaweeds are along the shore and on rocks depending on the substrate

- Where do they get shelter, food and water?

Ducks and other shore birds may tuck their heads under a wing to rest or stay sheltered; they may hide their young near rocks and crevices; they find food in the seaweeds and on the sandy and muddy bottom. Moon snails can retract into their shells for shelter or safety; a slime coat helps them stay attached during wave action or tides; they drill holes in clams and other mollusks and eat them. Green crabs can burrow into the substrate or hide in seaweed or crevices in the rock; they eat small clams by crushing their shells. Raccoons and small wildlife have shelter in the land habitat often in small holes, dens, or burrows; they forage for food. Seaweeds do not seek shelter; they get nutrients from the waters surrounding them.

- How do they stay safe? See above

Section III

- What are physical habitats?* See below
- Explain the difference between rocky, sandy, muddy, and water column habitats? See below

Physical habitats are defined by their substrate (bottom) and water depth, which influence what organisms can survive and grow in a particular area. The substrate can be large rock outcrop to sand to mud or a combination. Rocks provide places for plants and animals to attach and grow, whereas, sand and mud do not. Sand and mud allow burrowing of organisms whereas rocky substrate does not. The water depth affects the sunlight which reaches the substrate or water column and influences the types of vegetation and the abundance of vegetation. The water depth of tidal ebb and flow affects the plants and animals; the pounding wave action affects the attachment and movement of species in the habitat. In Maine, our major marine habitats defined by physical characteristics are Rocky Habitats, Sandy Habitats, Muddy Habitats, and Water Column (no substrate).

Compared to the area covered by all marine habitats, the Rocky Shore is the smallest, yet it has the highest biodiversity for its small size, and should be protected the most. Its major threat is runoff from the land.(www.seafriends.org.nz/enviro/habiatat/intro)

The Water Column's physical characteristic is that it has no solid substrate. Within the water are places of different temperature, salinity, and density. The organisms may move up and down within the water column to stay in favorable conditions. Vertical mixing of large masses of water with different temperatures and salinities (for example, cold, less saline waters of the Gulf of Maine meeting with the warmer, more saline Gulf Stream influences the types of animals and phytoplankton that lives in the water column.

- What are Biogenic habitats?*

Biogenic habitats occur when plants and animals grow in such a way that they provide a place for other plants and animals to survive and grow. Biogenic habitats may provide places where other plants and animals can attach, hide, find shelter, and find food. In Maine, these are the habitats known as salt marshes, sea grass beds, kelp beds, shellfish beds, and cold-water corals. Biogenic habitats are created within a range of other physical habitats and environmental conditions. For example, a salt marsh may be located primarily in a muddy intertidal area, but it could be found in a rocky or sandy intertidal area as well.

- Explain the difference between salt marshes, sea grass beds, kelp beds, shellfish beds, and cold-water corals. These habitats are created by plants and animals.

A Salt marsh is a grass dominated habitat that extends from the low intertidal zone to the upper limits of the highest high tides. A Salt marsh is among the most biologically productive ecosystems in the world, supporting rich coastal and estuarine food webs. Geese, deer, voles, insects, snails, and crustaceans consume vegetation. Much of the plant matter enters the food web after it dies, it is broken down into smaller particles that are swept away by the tides to provide food for crabs, shellfish, and several species of fish that feed, breed, and hide in tidal channels or on the flooded marsh surface.

A Sea grass bed is a term for flowering plants that live in low intertidal and subtidal marine environments. They are a critical habitat in the Gulf of Maine. Roots anchor the seagrass to the sediment, and seagrass absorbs nutrients from the water along the entire length of its blades,which could reach up to ten feet long. Eelgrass is one of the dominant species of seagrass, which can tolerate a wide range in temperature and salinity, and can grow in sand or mud or on small patches of mud between cobbles or boulder. Eelgrass can live anywhere that the water is relatively clear as long as it has the right amount of light.

A Kelp bed forms a distinct type of underwater habitat. The large flat structures create an almost under water canopy similar to forests on land. Kelps are found from the lower intertidal zone to about 40 meters in depth. The holdfast will attach to rocks and docks, as well as anything else that presents a hard substrate. The large structures provide protection from predators and harsh environmental conditions. Kelp holdfasts provide microhabitats for small invertebrates (snails and juvenile mussels). Kelp contributes to nutrients recycling by absorbing inorganic nutrients and then reentering the food web as dead tissue.

A Shellfish bed can be found in the intertidal and subtidal zone and from estuaries to far offshore. The 3 types of shellfish beds in the Gulf of Maine that have become biogenic habitats for other species are mussel beds, oyster beds, and scallop beds. Small animals can find refuge in the crevices among the shellfish, or they may attach themselves to the shells. The small fish can hide to ambush prey, avoid predators, or escape water currents.

There is very little data on Cold-water coral in the Gulf of Maine, but a reef was discovered close by near Nova Scotia and Newfoundland. Fishermen in the Gulf of Maine have found large corals in their nets, however. The corals can form a unique habitat that attracts a wide diversity of other species from suspension feeding invertebrates such as basket stars and anemones to fish, shrimp, crabs, sea stars, sea slugs, snails, and others.

(Except as cited within the notes, the information on habitats comes from Tyrrell, M.C. 2005. *Gulf of Maine Habitat Primer*. Gulf of Maine Council on the Marine Environment. www.gulfofmaine.org,vi+54pages)

- What habitats have been formed by human activity? Learn about Invasive-Plant habitats and Fouling communities

There are some physical and biogenic habitats that have developed due to human activities. They may have formed on the surfaces of structures that are placed in the water such as docks or other structures and are called Fouling communities, or they may be an invasive species that has established itself due to shipping, aquaculture, the release of aquarium pets or some other human activity and are called Invasive-Plant habitats. Often they upset the normal balance of the ecosystem and are not looked upon as habitats to preserve.

- How have the plants and animals adapted to living where they live?

Plants and animals have adapted in many ways. Some have shells that protect (crabs, clams, mussels, periwinkles, snails, etc), some have slime coats prevent drying out,(seaweeds), some attach to rocks to keep from being moved during heavy winds and wave action and to stay anchored near the water column to preserve moisture during low tide, some organisms move in and out with the tide, some organisms go into tidal pools or seaweeds, some burrow into the sand or crevices in rocks during the low tides.

- How do clams and some of the other species found in this habitat get shelter, food and water?

Some of this information may be repeating information in Section I. Clams use their siphons to draw water rich in plankton inside their shells. They get shelter by burrowing into the substrate of sand or mud. A source of food for crabs, moon snails, and black ducks is the clams. Their bodies are able to regulate salts so they can use salt water where humans need fresh. Seaweeds take in nutrients from the water.

- What would humans need to do in order to survive here?

Humans cannot survive in this habitat. They would need food, water, and oxygen, shelter from the high winds, wave action and current, temperature changes, seasonal changes, sunlight, salt water and rainfall, and protection from predators. They would have to develop adaptations to all of these environmental stressors.

- What does it mean to participate in a "sampling" of a marine habitat? How can this information be used?

A sampling can be done by setting up a quadrat sampling at low, middle, and high tide areas. Quadrats can be tossed down, and students can record what is found in the quadrat. Students can be taught how to determine the age of the seaweed, ascofillum SP?? By counting the bladders found on a main stalk of the plant. A sampling can be done by taking coffee cans and pressing them into the mud or sand to take core samples of soil. The soil can be sieved by dumping it into a simple unit similar to

the ones used in the clam project (4 wooden sides, screen bottom, and open top and washing it in the salt water to let the dirt/sand rinse out. Students can then count plants or animals that are found. A sampling is important for scientists to find out what is surviving in a particular area. The data can be saved and sampling can be done at other time intervals.

- How will the plants and animals be affected by the change of seasons in this habitat?

The plants and animals will adapt to the changing conditions of the habitat they live in various ways. Some birds will migrate; others will stay. Some animals will burrow deeper; the temperature changes of the water will not affect the cold-blooded animals as much.

- What happens to the sea water level over a period of time?

Over time the sea level rises and falls due to the melting and refreezing of glaciers. The land level rises and falls as well. As glaciers form on the land, they press down on the land, as glaciers melt, the land "bounces back". (www.bigelow.org/generalzonation/photo2)

- How can we record this event?

Maps have been made to record the depths and features of the coastal areas

- How does the water level affect the plants and animals that live here?

As the tides rise and fall each day, the animals have had to adapt to living in the air for several hours. If the water level was a permanent change, animals would probably move to a dry area, plants would die out or adapt, the habitat would gradually change.

- How do temperature, salinity, wave action, wind, sun/light, and substrate affect the organisms that live in the marine habitat?

This answer is provided on the Sea Vs.Land worksheet located with the worksheets for Lesson 13

- How do the plants and animals interact in the same habitat?

See the Biotic Factors that affect a habitat developed for Lessons 13-16. Briefly, animals and plants interact in several ways: being first in a habitat, competition for food and space, co-operating, altering the environment, being a predator or grazer, being a producer, being affected by disease, or being disrupted by disease.

- How can we help to protect the plants and animals in this habitat? Why should we want the plants and animals to survive?

We can protect plants and animals by respecting their habitats and being good stewards of the environment. We should want plants and animals to survive to help the environment stay in balance.

LESSON 14

Key Questions for Lesson 14 are all answered above in Lesson 13

Section 1

What are some common sights of the marine habitat?
What are some common sounds of the marine habitat?
Describe what can be felt at a marine habitat.
Describe what is smelled at a marine habitat.
Describe the marine habitat(s). Describe the marine habitat(s) that you visited.

Section II

Where does the clam live?
Where does the clam get food and water?
Where does the clam get shelter?
How does the clam stay safe?
What are some other species that exist in this marine habitat?
Where do they get shelter, food and water?
How do they stay safe?

Section III

What are physical habitats? Explain the difference between rocky, sandy, muddy, and water column habitats?
What are Biogenic habitats? Explain the difference between salt marshes, sea grass beds, kelp beds, shellfish beds, and cold-water corals
How have the plants and animals adapted to living where they live? (Hint to Instructor: Are there special coverings on their bodies or things they can do that have allowed them to survive in this habitat)
How do clams and some of the other species found in this habitat get shelter, food and water?
What would humans need to do in order to survive here?
What does it mean to participate in a "sampling" of a marine habitat? How can this information be used?
How will the plants and animals be affected by the change of seasons in this habitat?
What happens to the sea water level over a period of time?
How can we record this event?
How does the water level affect the plants and animals that live here?
How do temperature, salinity, wave action, wind, sun/light, and substrate affect the organisms that live in the marine habitat?
How do the plants and animals interact in the same habitat?
How can we help to protect the plants and animals in this habitat? Why should we want the plants and animals to survive?

LESSON 15

Key Questions

- How many low tides in a 24-hour period in Maine? How many high tides?

Maine has semidiurnal tides; 2 high tides and 2 low tides each day. They are on the average one hour later each succeeding day. So on occasion, the next high or low tide will go into the next day. (from

www.globalsecurity.org/military/library/policy/army/fm/55-501.chap 7.7-8)

- What is meant by ebb tide? flood tide? slack tide?

Ebb tide occurs as the tidal waters move off or recede from the coast, flood tide occurs when the tide moves onto the coast. Slack tide or slack water occurs when there is no horizontal motion of water and it occurs at each reversal of the current direction from high tide to low tide; from low tide to high tide

- What information can be found on a tidal chart? Where does this information come from? What is LDT and LST, why do we need to know the difference?

Much of the starting information on a tidal chart comes from the reports/data from weather buoys/stations. This information may include but is not limited to the date, range in feet of the tide, mean high water mark, mean low water mark, and time of day, am or pm. As the company or organization printing the chart will use formulas to predict the upcoming tides, accuracy cannot always be guaranteed. Many Tide charts will state the time they have been calculated so the tides will be more accurate. For information Daylight savings time – many areas in the world modify their time zones by one hour or more at various times in the year; since 2007 in the United States, most states change from 2:00 LST (local standard time) to 3:00 LDT (local daylight time) on the 2nd Sunday in March; on the first Sunday in November, the time changes from 2:00 LDT to 1:00 LST

- How is a tidal current chart different from a tidal chart? Why is knowledge of tidal current important? A tidal current is water moving horizontally in response to tides. At the coast, due to coastal landforms such as reaches, bays, inlets, rivers, estuaries current may move around or over at a faster speed; a tidal current chart pinpoints the latitude and longitude of an area and gives the current's changing speeds; changes in current can greatly affect navigation and create some dangerous areas
- How are spring tides different from neap tides?

Spring tides are higher than average tides, caused when the sun, moon, and earth are in alignment and the gravitational forces of each work together. Spring tides

occur on the new moon and the full moon. Neap tides are smaller than spring tides, occurring on the 1st and 3rd moon quarters when the forces of the sun and moon are perpendicular to each other in relation to the earth. Of note, is that the range of the tidal height is a gradual process for the most part, where semidiurnal (daily tides of 2 highs and 2 low)tides occur

- What is a tidal bore? Where might a tidal bore occur?

A tidal bore is a wave of water of the incoming tide (flood tide) moving in the opposite direction of the normal flow of water in a river or stream. The river is flowing downstream, the bore is moving upstream. It can be a few inches to several feet high depending on the tidal situation at the time. It often occurs when the water from a wider bay moves into an inlet or river, and a bore usually occurs in an area where there is a fairly large tidal range.

- What are semidiurnal tides? Diurnal tides? Mixed tides?

Semidiurnal tides are two highs and two lows each day of similar range in tidal height. One high might be 7 feet with the low at 1 foot; the next high may be 6.8 feet, the next low, 1.3 feet. Diurnal tides are one high and one low each day, with each subsequent high and low showing a slight change in range. On the first day, the high might be 7 feet, the low 1 foot, on the second day the high might be 6.9, and the low might be 1.3 feet. Mixed tides are where successive high water and low-water ranges differ greatly. One tide might be 7 feet at high water and 1 foot at low; the very next tide might be 5 feet at high and 3 feet at low.

- Explain what happens to the level of the tides during the phases of a moon cycle from new moon to full moon to new moon. How does the moon's elliptical orbit affect the tides? How does the moon's perigee or nearest point of orbit affect the tides? How does the moon's apogee or farthest point of orbit affect the tides?

The information presented here represents the cycle and ranges as observed in the Northern Hemisphere. The tidal range changes as the moon revolves counterclockwise around the earth. From New Moon (moon not visible) through Waxing Crescent (right side of moon is visible) to 1st Quarter Moon (50% of the right side of moon is visible) to Waxing Gibbous (right side of moon is visible) to Full Moon (100% of the moon fully visible) through Waning Gibbous (left side of moon is visible) to 3rd Quarter Moon (50% of left side of moon is visible) to Waning Crescent (left side of moon visible) to New Moon (0% moon or not visible) in a gradual way. The range of tides is the largest (spring tides) with the highest highs and the lowest lows on the new moon and the full moon. The range of tides is much less during the neap tides that occur on the 1st quarter moon and the 3rd quarter moon. Starting with the new moon, the tidal range

gradually grows smaller during the waxing crescent phases to the 1st quarter moon, the tidal range gradually increases during the waxing gibbous to the full moon, the range decreases during the waning gibbous phases to the 3rd quarter moon, and finally the tidal range increases to the new moon. The tide range changes are caused for the most part by the alignment and position of the moon in relation to the earth and sun. The forces of the moon affect the earth's tide the most, because of its closer proximity to the earth.

Phases are described as viewed from earth in the Northern Hemisphere; phases are New moon (no moon visible or 0%), Waxing crescent (1-49% moon visible on right side), First quarter moon (50% of the moon visible on the right side), Waxing gibbous (51-99% of the moon visible on the right side), Full moon (100% of the moon visible), Waning gibbous (51-99% of the moon visible on the left side), Last/Third quarter moon (50% of the moon visible on the left side), Waning crescent (1-49% of the moon visible on the left side)

Refer to figure 8r-2 and 8r-3 and the text explanation of the alignment of sun, moon, and earth to produce spring tides

(Pidwirny, M. (2006)"Ocean Tides". *Fundamentals of Physical Geography, 2nd Edition*.01-10-2012.http://www.physicalgeography.net/fundamentals/8r.html

Refer to a source that would show pictures to help illustrate moon phases. www.noaa.gov and www.wikipedia.org/wikii/Moon_phases provide some good pictures and illustrations to use with your students. Be sure to check copyright disclaimers before printing material from websites.

The moon has an elliptical orbit or oval, which causes an affect on tides as well. When the moon is closest to the earth (perigee), the tides are larger than normal. This happens 3 or 4 times a year. If perigee coincides with a storm surge of water, devastation and flooding could occur. At its perigee, the full moon looks much larger than normal. Opposite of perigee is apogee, which means when the moon is at its farthest point in orbit from the earth. The moon's affects on the tidal range are less at this time.

- What are weather buoys? What can be learned from them?

The terminology for the data taken from weather buoys will be defined here and in the Master vocabulary list. Many of the terms may be familiar to students who have studied weather. Most of the terms were defined in the glossary found at www.weather.gov/glossary, which is a part of NOAA's National Weather Service.

Some of the information weather buoy/station provides are wind direction, wind speed, wind gust, wave height, dominant wave period, average wave period, atmospheric pressure, pressure tendency, air temperature, water temperature, dew point, ice accretion, wind chill (combines wind speed, gust and air pressure). In addition, the location, type of buoy, elevation, and position relative to its surroundings is also stated.

Wind direction is the true direction from which the wind is blowing at a given location (i.e., wind blowing from the north to the south is a north wind). It is normally measured in tens of degrees from 10 degrees clockwise through 360 degrees. North is 360 degrees. A wind direction of 0 degrees is only used when wind is calm.

Wind speed is the rate at which air is moving horizontally past a given point. It may be a 2-minute average speed (reported as wind speed) or an instantaneous speed (reported as a peak wind speed, wind gust, or squall).

Wind gust is a sudden brief increase in the speed of the wind. According to the U.S. weather observing practice, gusts are reported when the peak wind speed reaches at least 16 knots and the variation in wind speed between the peaks and lulls is at least 9 knots. The duration of a gust is usually less than 20 seconds.

Wave height is the distance from wave trough (lowest part of a wave) to wave crest (highest part of a wave).

Dominant wave period- the time, in seconds between the passage of consecutive wave crests past a fixed point is the wave period. Adding the word “dominant” to “wave period” and observing the data makes one believe the dominant wave period is the longest time period between wave crests that occurred during a fixed time period.

Average wave period-Observation of the data makes one believe the average wave period is the average of the consecutive wave crests in a fixed amount of time.

Atmospheric pressure is the pressure exerted by the earth’s atmosphere at any given point, determined by taking the product of the gravitational acceleration at the point and the mass of the unit area column of air above the point

Pressure tendency is the character and amount of atmospheric pressure change during a specified period of time, usually 3-hour period preceding an observation.

Air temperature is a measure of the internal energy that air contains. Temperature is the most measured quantity in the atmosphere.

Water temperature is a measure of the internal energy that water contains at a given time.

Dew point is a measure of atmospheric moisture. It is the temperature to which air must be cooled in order to reach saturation (assuming air pressure and moisture content are constant). A higher dew point indicates more moisture present in the air. It is sometimes referred to as Dew Point Temperature, and sometimes written as one word (Dewpoint).

Ice accretion- the growth of a precipitation particle by the collision of a frozen particle with a supercooled liquid water droplet, which freezes upon impact.

Wind chill (combines wind speed, gust and air pressure)-Reference to the Wind Chill Factor; increased wind speeds accelerate heat loss from exposed skin, and the wind chill is a measure of this effect. No specific rules exist for determining when wind chill becomes dangerous. As a general rule, the threshold for potentially dangerous wind chill conditions is about -20°F.

- What are seamarks? What can be learned from them?

Also called sea mark or navigation mark is a form of aid to navigation and pilotage aid which identifies the approximate position of a maritime channel, hazard, and administrative area to allow boats, ships, and seaplanes to navigate safely. They indicate channels, rocks, shoals, mooring positions, areas of speed limits, traffic separation schemes, submerged shipwrecks, and for many other purposes. Some are only intended to be visible during the day (daymarks) and others may have a combination of lights, reflectors, bells, horns, whistles and radar reflectors to make them usable at night and in conditions of reduced visibility. They are shown on nautical charts. (from Wikipedia at http://en.wikipedia.org/wiki/Sea_mark)

- What are bell buoys? What can be learned from them?

A buoy attached to the seabed with a bell attached to it. The water movement causes the bell to sound. This type of buoy would alert the navigator to his/her surroundings and could be heard rather than need to be seen. Bell buoys had various tones depending on their construction.

Lesson 16under construction

LESSON 17

Key Questions

How is a coffee can used to take a sample?

One end is cut out of a coffee can. Any sharp edges would need to be to sanded in some way. The can is pressed down into the substrate. A person covers the end of the can that is in the substrate and removes the can and contents from the substrate, keeping the hand over the opened end until the contents can be emptied into the screening box.

What part does the screening box play?

The coffee can contents are sieved by taking the screening box to the salt water and rinsing out the substrate. Depending on the lesson, a count of the remaining contents will be taken.

What precautions must we take while we take samples?

When taking core samples in the field situation, all caution should be taken to preserve the habitat by leaving it the way it was before the experiment. All current marine regulations for that particular area must be followed

LESSON 18

Key Questions

- What is a quadrat?

A quadrat is a metal, wood or plastic square which is placed on the area being sampled; used to isolate a small area for the purpose of counting organisms in the sample area. (DEI has used 30 cm X 30 cm quadrats successfully with several age groups)

- How is a quadrat used to take samples of marine plants/animals?

Because it would be nearly impossible to count every species in an area due to time and expense, sampling has become an accepted way to determine on average the number of species that exist in a particular area. Quadrats are placed at intervals in a particular area and the specific data that is wanted at the time is recorded. Later, mathematically, calculations can be made to give an idea of what a larger area would possibly contain of this same species. The Instructor could lead a discussion about marine sampling and how it is being used to help preserve natural and commercial resources.

Seaweed is currently being harvested in the coastal area. The discussion could center on the use of the age count of *Ascophyllum nodosum* prior to and after a harvest season to check the health and growth of the plant in a particular area.

- What precautions must the people who are taking samples follow to make sure their data are accurate?

The group needs to be set up in an organized manner so that samples are not repeated and enough samples are done to make the data as accurate as needed for the purpose of the sampling. Safety practices must be followed as the marine habitat has very slippery areas.

- How can we recognize *Ascophyllum nodosum*?

Ascophyllum nodosum is a brown seaweed that is characterized by long fronds that look like straps. The fronds hang down and drape on the intertidal rocks. Upon the fronds can be found elliptical-shaped nodes at varying intervals. The nodes represent a year's growth for that particular plant.

- What does a holdfast look like? What is its purpose?

A hold fast is at the base of the plant and attaches it to a substrate such as a rock. It is made from the plant itself and could be compared to the roots of a land plant, except that a holdfast grips the surface.

- Why should good stewardship practices be followed while taking samples?

Conservation and stewardship practices should be followed so that the group does not damage other species or the species being counted.

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