Northeastern University
Marine Science Center

Rocky Shore Field Experience
Teacher Resources

Grades 6-8

Thank you for your interest in the educational programs at the Marine Science Center!

This packet will provide you with information on how to incorporate a marine science field experience into your science curriculum, including background information on program content, what to expect during your visit, pre- and post-visit classroom activities and how these field experiences and activities satisfy requirements of the Massachusetts Curriculum Frameworks. For information regarding logistics and planning your visit, please see the Group Visit Registration pack.

Contents

A. What to Expect on Your Visit

PROGRAM DESCRIPTION

A typical field trip to the Marine Science Center consists of three, 45-minute components:

1. *Introduction to the rocky shore/meet rocky shore organisms*
    - Outreach staff will lead a discussion about the rocky shore, topics covered include:
        - Tides: gravitational forces, spring vs. neap, tidal range, timing, occurrence, how tides influence life on the rocky shore
        - Challenges/stressors facing animals on the rocky shore:
            - Abiotic factors such as changes in temperature, salinity, dissolved O_2, wave action, desiccation
            - Biotic interactions such as competition and predation
        - Adaptations of organisms living on the rocky shore
        - Taxonomic classification of organisms on the rocky shore
    - Outreach staff will lead students in exploring our touch tanks, where they can meet and touch animals that live on the rocky shore. Teachers and chaperones are asked to enforce rules and ensure students treat animals with respect.

2. *Rocky shore field experience*
   **Students must wear closed toed shoes and demonstrate good behavior in order to participate in the rocky shore activity.
    - Outreach staff will introduce students to the tools scientists use to collect data on the rocky shore and explain the activity and the rules on the rocky shore.
    - Students will break into groups of 3-4 and each group will be responsible for bringing their equipment down to the rocky shore. Teachers and chaperones are asked to ensure that students form groups and gather equipment.
    - On the shore, groups will start low on the shore, place their quadrat in a tide pool and collect data on the physical characteristics (temperature, salinity) and living organisms contained in the quadrat. Students will count mobile organisms and estimate the percent cover of sessile organisms in their quadrat. Students will then move to the high intertidal to complete an identical survey in a high tidepool for comparison.
    - Field guides will be provided to help students identify the seaweed and invertebrates living in the tidepools. All data will be recorded on the data sheet provided in this pack.
    - Teachers and chaperones should circulate between the groups, assisting students with the activity and keeping them on task, as well as enforcing rules to ensure safety.

3. *Tour of East Point*
    - Outreach staff will lead students around the grounds of the Marine Science Center and to the top of East Point while discussing the history of the area, important geological features, and some current research at the MSC. Topics include:

- Military history of East Point: bunkers, triangulation towers, submarine detection strip, Nike Missile Silo.
- Geology of East Point: tombolo, home to first shelled fossils, rock signatures provide evidence of Pangea, igneous intrusions create sills and dikes, slant of rocks due to mountain building.
- Nahant as a historically popular destination for tourists and scientists alike.

Included in this pack is a worksheet for students to complete using information that they learned in the classroom and tour portions of the program. This worksheet can be filled out during the program or teachers can use it as a follow-up/assessment activity, depending on teacher preference.

Program Modifications

The duration and specific content of each component may be modified depending on time constraints or requests from teachers. If you have an activity in mind that is not covered here, or would like Outreach staff to place particular emphasis on a certain component of the program outlined above, please contact us prior to your visit to discuss modifications to the typical program. Additional activities available include: marine animal dissection, an interactive food web activity, and seaweed identification and pressing.

Weather Cancellation Policy

In the event of inclement weather we generally leave it to the visiting group to decide to reschedule/cancel the trip. We will proceed with the program as normal in the event of rain, and encourage teachers, chaperones and students to dress appropriately if rain is in the forecast. In the event of lightning or other dangerous weather conditions we encourage teachers to reschedule, but we understand that this is not always possible and we have indoor activities that can replace the rocky shore field survey, such as marine animal dissection, an interactive food web activity, and seaweed identification and pressing.

Preparing Students and Chaperones

Prior to visiting the Marine Science Center, teachers are encouraged to utilize the resources provided in this pack in order to prepare their students for the visit. This includes not only communicating with them what to bring and what to expect, but also leading activities that will introduce them to the concepts they will be learning and activities they will be doing during their visit. We hope that by providing these tools to teachers, we can work together to make a visit to the Marine Science Center more than just a one-time field experience, but an experience that can fit into a larger natural sciences curriculum.

Teachers should communicate with chaperones prior to the trip regarding what to bring and what to expect, and distribute the Teacher/Chaperone Guidelines handout, provided below.

Northeastern University
Marine Science Center

FIELD SURVEY

Today's Date: _____

Group members: _____

Weather (circle one) Sunny Partly Cloudy Mostly Cloudy Overcast Rainy

Cloud Types _____

Wind speed <5 mph 1-5 mph 6-10 mph 11-20 mph > 20 mph

Beaufort scale (circle one) 0 1 2 3 4 5 6 7 8 9 10 11 12

Air temp _____ °F *(sit thermometer in shade for at least 30 seconds)*

Algae species

Phylum/Class	Common name	Scientific name	% Cover in Low	% Cover in High
Brown algae	Kelp	*Laminaria saccarina*		
	Knotted wrack	*Ascophyllum nodosum*		
	Rockweed	*Fucus spp.*		
Red algae	Dulse	*Palmaria palmata*		
	False Irish moss	*Mastocarpus stellatus*		
	Irish moss	*Chondrus crispus*		
	Filamentous red algae	Various		
	Coralline algae (branching or crusting)	Various		
Green algae	Dead man's fingers*	*Codium fragile*		
	Sea lettuce	*Ulva lactuca*		
	Filamentous green algae	*Cladophora spp.*		
	Gutweed	*Ulva intestinalis*		

Tidepool physical characteristics

Parameter	Low tidepool	High tidepool
Water temperature	**°F**	**°F**
Salinity	**ppt**	**ppt**

Animal species

Phylum/ Class	Common name	Scientific name	# in Low	# in High
Molluscs	Smooth periwinkle*	*Littorina obtusata*		
	Common periwinkle*	*Littorina littorea*		
	Atlantic dog whelk	*Nucella lapillus*		
	Common slipper snail	*Crepidula fornicata*		
	Blue mussel	*Mytilus edulis*		
Echinoderms	Forbes sea star	*Asterias forbesi*		
	Green sea urchin	*Strongylocentrotus drobachiensis*		
Crustaceans	Shrimp	Various		
	Green crab*	*Carcinus maenas*		
	Rock crab	*Cancer irroratus*		
	Asian shore crab*	*Hemigrapsus sanguineus*		
	Long-clawed hermit crab	*Pagurus longicarpus*		
	Acorn barnacle	*Semibalanus balanoides*		
Other	Bryozoans (lacy crust)*	Various		
	Tunicate (sea squirt)*	Various		
	Springtails	*Anurida maritima*		
	Sponges	Various		

**** Indicates Invasive Species***

TEACHER/CHAPERONE GUIDELINES

Thank you for your interest in our educational programs at the Marine Science Center! Your visit will be filled with hands-on activities both inside and outside, and as a teacher/chaperone, we ask that you keep students safe and on-task. Our instructors will give directions and information to the students, so please help us by following and enforcing these guidelines:

- At least one teacher/chaperone must always accompany students to the restrooms.
- While on the rocky shore, teachers/chaperones should be assigned to particular groups of students, or at least spread out so that there are adults on the low tide areas and the high tide areas.
- There is no climbing on the high rocks and no swimming at any time. Students should not be in any water above the ankle.
- As necessary, remind students to be respectful of animals, handle them carefully, and observe any areas designated as no-touch zones.
- Students who do not have appropriate footwear for the rocky intertidal may be asked to stay on the beach with a teacher/chaperone during that activity.
- Shoes must be worn at all times during the visit, even on the lawn.
- We do not allow electronics other than cameras out during our programs. Students may take pictures with a phone, but we advise them not to bring them onto the rocky shore.
- Nothing should be removed from the Marine Science Center except worksheets, and nothing should be left behind. We will provide trash bags for lunchtime, and there are recycling bins available as well.
- We know you are curious and smart too! But please allow students to answer questions and figure things out on their own to the greatest extent possible. Having said that, please maintain order and focus in your group, and facilitate the student completion of tasks when they are stuck.

Thank you for your cooperation

FIELD TRIP ETIQUETTE

Preparing Students

Before your outdoor field trip, brainstorm with students about how everyone should conduct themselves. Below are some general themes to guide your discussion. If desired, the teacher can document the rules on a board or flip-chart paper.

Established rules of the site

- Challenge students to think about who lives in the habitat they are exploring?
- How should students behave to ensure they respect these inhabitants?
- What rules are in place to protect these inhabitants?
- General discussion on proper handling/respect of living things

School rules

- Students should conduct themselves as they would in school
- Reminders about any field-trip specific rules
- Students are responsible for representing their school via good behavior

Safety

- Ask students to brainstorm any dangers or hazards at the field trip site
- How should students avoid these dangers?
- What rules are in place to avoid dangers or respond to potential hazards?

Logistics

- Allow students to ask questions about field trip logistics. This will help to avoid distraction during the field trip.
- Give them all the details such as: how long is the bus ride, what will we be doing, is there a gift shop, when will we eat lunch?
- Discuss what students should wear/bring, and what they should not. Send home a handout with this information before the field trip.

If the students don't think of everything while brainstorming, be sure to mention these general rules regarding visiting coastal habitats:

- Remind students that they shouldn't take anything home and to be sure not to leave behind any equipment, personal belongings or trash.
- Its ok to get your feet wet, but no one should be more than ankle deep in the water.
- On the rocky beach, no one should climb on high rocks above where seaweed grows.

Preparing Chaperones

Invite chaperones to attend the in-class discussion of field trip etiquette and even the pre-visit educational activities that you do to prepare students for the field trip. The more information that the chaperones are familiar with, the more they can help students get the most out of the experience. Share resources with chaperones such as the field trip etiquette document, a schedule of activities for the day, procedures for activities, what to bring handout, site map or website where they can find out more information about the site.

WHAT TO BRING

- The weather in Nahant is usually a bit cooler and windier than on the "mainland". Layers of clothing, a change of clothing, and/or rain gear is highly recommended. A hat is advisable.
- Though swimming is not permitted, feet WILL get wet while tidepooling, so rubber-soled shoes such as boots, water shoes, or old sneakers are recommended. Participants wearing slip-on sandals, flip flops, Crocs, Tevas, or heels may be denied participation in tidepooling.
- Participants should bring sunscreen and/or hand sanitizer, as they will not be provided.
- Each person should bring an ample supply of water, there is a water fountain to refill water bottles, but no water bottles/drinks/cups will be provided.
- Participants may bring snacks and lunch to eat onsite during designated breaks only.
- With the exception of cameras, all electronic devices must be out of sight at all times.

B. Classroom Resources

Background Information for Teachers

This section of the packet provides details regarding the type of information students will learn during a typical field experience at the Marine Science Center. This information is provided in order to help teachers prepare their students for the visit, as well as plan/implement pre and post extension activities to ensure students get the most out of a Marine Science Center visit.

The Rocky Shore

The rocky **intertidal** is a zone of rocky coastline that falls between high tide and low tide. The rise and fall of the tides creates an area that is covered by water part of the day and exposed to air for part of the day. Below the rocky shore is the **subtidal** zone, which is always submerged in water, and above the rocky shore are uplands, which waves rarely reach. These rocky shores generally occur in relatively exposed waters, and are generally comprised of bedrock and other large glacial rocks and cobble.

These rocks provide a hard substrate for a variety of **sessile** (non-moving) organisms to settle. Additionally, many mobile organisms dwell in the cracks, crevices and **tidepools** left behind as the water retreats to the low tide line. Due to the habitat provided by the rocks, the tide pools, and the foundations species living here, the rocky shore hosts variety of life that is much more apparent at first glance compared to the sandy beach. **Invertebrates** and seaweeds (red, green and brown) dominate life on the rocky shore. Large, brown seaweeds form dense canopies that trap water and provide relief from the stressful conditions experienced by organisms during low tide. Cooperation between organisms is important for survival in this stressful environment.

The rocky shore has several distinct zones that are defined by elevation relative to the water's edge and distinct geologic features. These include a low, mid, and high zone, and the splash zone above. The intertidal is not uniform. These distinct zones are submerged in water and exposed to air for different lengths of time, resulting in increasing physical stress associated with higher tidal elevations. This physical stress includes drastic changes in **temperature**, **salinity**, **dissolved oxygen** levels, and **pH** in high tidepools during low tide when they are separated from the flow of seawater. Additionally, organisms living directly on the rocks outside of tidepools must deal with **desiccation** stress due to emersion. Organisms have adapted to these stressors by developing high tolerances for changes in these **abiotic** conditions. For instance, a periwinkle in a high tide pool is able to survive in temperatures ranging from below freezing to over 90 degrees F, and salinities ranging from 15 to 45ppt. Wave action is another abiotic stressor on the rocky shore. Large waves can dislodge organisms from the rocks, washing them into deeper waters, or to the uplands beyond the intertidal. As a result many intertidal organisms have adaptations that allow them stick to rocks such as tube feet in sea stars and byssal threads in mussels.

In addition to abiotic stressors, **biotic** stressors include competition and predation. Isolated tidepools contain limited quantities of food and oxygen, leading to competition for these

essential resources. Space is at a premium on rocky shores, and organisms complete for a spot on the rocks to settle. Competition is so intense that organisms even settle on top of one another. Like land plants, seaweeds that grow on other seaweeds are known as epiphytes. Sessile animals such as mussels, barnacles and tunicates settle on each other as well as on larger organisms such as crabs and snails, and are referred to as epibionts.

Intertidal organisms are subject to predation from both land and sea. At high tide large subtidal crabs and fish can venture into the intertidal for a snack. Similarly, at low tide, terrestrial predators such as seabirds, rodents and raccoons might make a meal out of tidepool creatures.

Despite all these challenges and stressors facing organisms in the rocky intertidal, the cold, nutrient-rich waters of the temperate coastal climates in which these habitats occur, allow the rocks to support a large diversity of life.

History of East Point

Nahant has been a popular destination for recreation, science and military defense for years. Nahant is a special type of peninsula known as a tombolo, which means it is nearly an island, only connected to the mainland via a small strait or sandbar. Historically Nahant was a popular vacation destination among affluent Bostonians. In the 1800s hotels and summer vacation homes dominated the town. East Point, the current site of the Marine Science Center was home to several hotels.

After several fires eliminated the hotels from the site, the military established a presence on East Point, during WWII, due strategic location of Nahant, extending out into Boston Harbor. Remnants of the military presence can still be seen at East Point, including 3 underground bunkers once used for protection and artillery storage, 3 triangulation towers previously used for detecting invading enemies and the infrastructure of a primitive submarine detection device. Post-WWII the military presence persisted with the construction of a Nike Missile Silo.

In 1967, Northeastern University established a marine science lab at East Point with the goals of marine science research, education, and community outreach.

Geology of East Point

East Point, Nahant is well known as an important geological study site due to the unique rocks that make up its terrain, some of which can be found no where else in New England. One reason that the rocks here fascinate geologists is that some rocks in Nahant provide evidence for the theory of Pangea. Using techniques such as Stable Isotope Analysis and Radiocarbon Dating, scientists have shown that rocks in Nahant have the same signatures as rocks in Northern Africa. This indicates that when the African continent split from North America, rocks from Africa were left behind in Nahant.

The sheer cliffs in Nahant also provide visual illustrations of some key geological concepts. The cliffs at East Point are all tilted at a North facing 45 degree angle, evidence that these

rocks were involved in **Mountain Building** as Africa crashed into North America due to the movement to continental plates.

The rocks that form of the cliffs of East Point have a base of **sedimentary rock** such as limestone (grey/white) and siltstone (grey, green and black). This rock is around 580 million years old. Around 400 to 500 million years ago, hot molten rock beneath the earth, known as **magma**, rose to the surface. As it rose, the magma fractured and displaced the sedimentary rock, filling in the cracks it created. These "**igneous intrusions**" form distinct colored stripes and sections on the rocks at East Point. A horizontal intrusion is known as a **sill** and a vertical intrusion is known as a **dike**.

Furthermore, Nahant is home to some very special fossils, which give geologists and paleontologists clues as to what kind of animals inhabited this area millions of years ago. Notably, the rocks here are home to the oldest fossils of shelled organisms (ancestors of modern Mollusks).

CONNECTION TO MASSACHUSETTS CURRICULUM FRAMEWORKS (Grade 6th-8th)

	Classroom	Rocky Shore	Touch Tank	Tour	Pre / Post Activity
Science and Technology/Engineering					
Earth and Space Science					
• 6.MS-ESS1-1a. Develop and use a model of the Earth-Sun-Moon system to explain the causes of lunar phases and eclipses of the Sun and Moon	•				
• 6.MS-ESS1-4. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time.				•	
• 7.MS-ESS2-2. Construct an explanation based on evidence for how Earth's surface has changed over scales that range from local to global in size.		•		•	
• 7.MS-ESS2-4: Develop a model to explain how the energy of the sun and Earth's gravity drive the cycling of water, including changes in state, as it moves through multiple pathways in Earth's hydrosphere	•	•	•		•
• 8.MS-ESS1-2: Explain the role of gravity in ocean tides, the orbital motions of plants, their moons, and asteroids in the solar system.	•	•			
• 8.MS-ESS2-6: Describe how interactions involving the ocean affect weather and climate on a regional scale, including the influence of the ocean temperature as mediated by energy input from the sun and energy loss due to evaporation and redistribution via ocean currents		•		•	
• 8.MS-ESS3-5. Examine and interpret data to describe the role that human activities have played in causing the rise in global temperatures over the past century.	•	•	•	•	•
Life Science					
• 6.MS-LS1-3: Construct an argument supported by evidence that the body systems interact to carry out essential life functions		•	•		•
• 6.MS-LS4-2. Construct an argument using anatomical structures to support evolutionary relationships among and between fossil organisms and modern organisms.	•	•	•		•
• 7.MS-LS1-4: Construct an argument based on evidence for how characteristic animal behaviors and specialized plant structures increase the probability of successful reproduction of animals and plants	•	•	•		•

Life Science (continued)	Classroom	Rocky Shore	Touch Tank	Tour	Pre / Post Activity
• 7.MS-LS2-1. Analyze and interpret data to provide evidence for the effects of periods of abundant and scarce resources on the growth of organisms and the size of populations in an ecosystem.	•	•			•
• 7.MS-LS2-2: Explain how relationships among and between organisms in an ecosystem can be competitive, predatory, parasitic, and mutually beneficial and that these interactions are found across multiple ecosystems	•	•	•	•	•
• 7.MS-LS2-3: Develop a model to describe that matter and energy cycle among living and nonliving parts of an ecosystem and that both matter and energy are conserved through these processes	•	•	•		•
• 7.MS-LS2-4: Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.	•	•			•
• 7.MS-LS2-6: Explain how changes to the biodiversity of an ecosystem-the variety of species found in an ecosystem-may limit the availability of resources humans use.	•	•		•	•
• 8.MS-LS1-5: Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms.	•	•	•	•	•
Physical Science					
• 6.MS-PS2-4. Use evidence to support the claim that gravitational forces between objects are attractive and are only noticeable when one or both of the objects have a very large mass.	•	•			
English Language Arts					
Reading Standards for Informational Texts					
• RI.7 (6-8). Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.	•	•	•	•	•
Speaking and Listening Standards					
• SL.1 (6-8). Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade level topics, texts, and issues, building on others' ideas and expressing their own clearly	•	•	•	•	•

Speaking and Listening Standards (continued)	Classroom	Rocky Shore	Touch Tank	Tour	Pre / Post Activity
• SL.2 (6-8). Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.	•	•	•	•	•
Reading Standards for Literacy in Science and Technical Subjects					
• RST.1 (6-8). Cite specific textual evidence to support analysis of science and technical texts.	•	•			•
• RST.3 (6-8). Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.	•	•			•
• RST.4 (6-8). Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.	•	•	•	•	•
Mathematics					
Statistics and Probability					
• 6.SP-5. Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations. b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.	•	•			
• 7.SP-1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.	•	•			

Statistics and Probability (continued)	**Classroom**	**Rocky Shore**	**Touch Tank**	**Tour**	**Pre / Post Activity**
• 7.SP-2. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.	•	•			
Comprehensive Health					
• 13.3 Describe methods and benchmarks for evaluating the state of the environment	•	•	•	•	•
• 13.4 Identify individual and community responsibility in ecological health	•	•	•	•	•
• 13.5 Evaluate solutions generated by science, technology/engineering, and individuals regarding ecological health problems (such as energy use, water use, waste disposal, and food shortage)				•	

Extension Activities

These in-school activities are designed to either prepare students for, or debrief students after their field experience. While some activities are particularly suited for either before or after, some are more flexible and can be conducted anytime as teachers see fit. All activities satisfy requirements of the Massachusetts Curriculum Frameworks.

Activity 1: Introduction to the rocky shore and Nahant

Materials:
Slide presentation (provided)
Map of Nahant (provided)
Rocky shore vocab list (provided)

Duration: 1 class period

Learning Objectives: Build on prior knowledge to learn what lives on the rocky shore, and the physical factors that influence life in this habitat.

Instructions:

- This activity introduces students to the field-trip site and prepares them for the trip, including an explanation of the activities on the trip, vocabulary and field-trip etiquette/safety.
- Teacher displays an image of a rocky shore and asks students if they have ever been to such a place. Students will be invited to share their experiences of the rocky shore in a group discussion. Discussion will continue as teacher presents the rocky shore Slide show and introduces students to vocabulary associated with the rocky shore.
- Teacher will pose questions such as
    - What kind of organisms live on the rocky shore?
    - What might make it hard or stressful to live on the rocky shore?
    - What kind of adaptations might organisms have to survive here?
- After the discussion of the rocky shore, teacher will show students a map of Nahant as an example of a rocky shore location. Teacher will lead a discussion about Nahant and the upcoming field trip.

Activity 2: Introduction to taxonomic classification

Materials:
Variety of seashells
Field guides (books and/or online)

Duration: 1 class period

Learning Objectives: Classify animals based on shared characteristics

Instructions:

- Students will be organized into groups of 4 to classify different types of shells based on characteristics observed. Groups will share and discuss their classification schemes with the whole group. The teacher will then show students how to use a field guide to identify organisms, shells in particular. Students will use the field guides to identify the types of shells they have been given.

Activity 3: Weather Observations

Materials:
Thermometer
Weather data sheet (provided)
Cloud Types Chart (provided)
Beaufort Scale Chart (provided)

Duration: 1 class period

Learning Objectives: Recognize how weather impacts living organisms, practice field sampling procedures

Instructions:

- Teacher will lead a discussion on weather and how it impacts all the living things on our planet. When scientists collect data in nature, they need to consider how the weather might impact the natural world which they are studying. Teacher will introduce several tools that scientists use to study the weather and how they work. Teachers will lead students outside to use the tools to make and record observations about the weather. This activity prepares students for weather data they will collect during a field experience at the Marine Science Center.

Activity 4: Rocky shore memory game

Materials:
Printed pictures of rocky shore organisms/objects (provided)
Printed names of rocky shore organisms/terms (provided)

Duration: 10-20 minutes

Learning Objectives: Review recently learned vocabulary

Instructions:

- Pairs of students will be given an envelope containing the vocabulary terms addressed in the Slide presentation and images representing those terms. Students will work together to sort the images with the correct term.

Activity 5: Research a rocky shore organism

Materials:
Research materials (books and/or online)
Presentation materials (posters and/or electronic)

Duration: 1-2 class periods

Learning Objectives: Become familiar with rocky shore species, practice research skills

Instructions:

- Students (on their own or in pairs) will choose a rocky shore organism to research. Students should focus on the specific habitat or niche of the organism, how it grows, eats and reproduces and special adaptations that allows it to live on the rocky shore.
- Students will present information on their organism to the class.

Activity 6: Construct a field guide

Materials:
Field guide template (provided)

Duration: 1-2 class periods

Learning Objectives: Become familiar with rocky shore organisms and classification methods

Instructions:

- Using information learned from previous activities, field trip or research (activity 4) students will create field guide pages for selected rocky shore organisms.
- Depending on grade level and time constraints, all pages can be combined into one field guide for the entire class, or smaller groups of students can collaborate to create a field guide among their group.

Activity 7: Practice Field Survey

Materials:
Quadrats or hula hoops
Pompoms, various sizes and colors
Yarn, various colors
Practice Quadrats data sheet (provided)
Pencils
Clipboards or notebooks

Duration: 1 class period

Learning Objectives: Become familiar with field sampling procedures

Instructions:

- This activity is designed to introduce students to the type of data they will be collecting on the rocky shore.
- Teacher will explain how scientists use tools like quadrats to focus their attention and make it easier to survey a large habitat.
- Teacher will explain how in this type of study scientists count the number of mobile organisms such as crabs or snails, but for sessile (non-moving) organisms such as barnacles or seaweed, scientists estimate the fraction or percent of the organism in the quadrat.
- In a large area (outdoors or in a large classroom/gym with ample floor space) teacher will scatter the mock rocky shore organisms (yarn and pompoms). Students will haphazardly place their quadrats and count the number and percent cover of items in the quadrats and record their findings on the Practice Quadrats data sheet.
- For a special treat, candy can be scattered among the yarn and pompoms and recorded in the "Other" rows on the data sheet.

Activity 8: Name that organism!

Materials:
Rocky shore organism photos (provided in field guide, be sure to remove names first!)

Duration: 10-15 minutes
Learning Objectives: Use prior knowledge to identify organisms

Instructions:

- In this assessment activity, ten images of rocky shore organisms will be displayed one at a time to the whole group. Students are given 3 minutes to individually use their field guide to identify and record the displayed organisms.

Activity 9: Rocky shore data analysis

Materials:
Rocky shore Field Trip Data Sheets (with data from trip)
Graphing materials (chalk/white board, flip chart, computer)

Duration: 1-2 class periods

Learning Objectives: Use quantitative skills to identify patterns in data. Represent data graphically.

Instructions:

- Teacher will first ask the students to recall the hypotheses they formed regarding how abiotic (temperature and salinity) and biotic (distribution and abundance of organisms) factors might differ in different areas of the rocky shore.
- Teacher will then prompt the students to guess how they might analyze the data they collected to determine if their hypotheses were correct.
- Teacher will lead students through calculating averages from all the individual groups that collected data and graphing the data.
- There are many ways to graph and analyze the data, some ideas include bar graphs with two bars displaying data collected in the high versus low zone (temperature, salinity, number of periwinkles etc.) Alternately, students could make two pie graphs, comprised of all the organisms and their relative abundances in the high and low zone.
- After graphs are made, teacher will prompt a discussion among students regarding the patterns revealed by the data. Did the data support the students' hypotheses? How did abiotic and biotic factors change between the high and low intertidal zone.
- Teacher will lead a discussion about some reasons why data sometimes does not support hypotheses such as variation in sampling location, human error and equipment error.

Activity 10: Construct a food web

Materials:
Pictures of rocky shore organisms
Food web worksheet and template (provided)

Duration: 1 class period

Learning Objectives: Identify trophic relationships and the way in which energy is transferred between organisms.

Instructions:

- Students will use the knowledge they have gained from field experiences and classroom activities to construct a food web with pictures of animals, identifying animals at different trophic levels (consumers, producers etc.)

Rocky Shore Vocabulary List

Intertidal
Tidepool
Evaporation
Salinity
Temperature
Tide
Adaptation
Elevation
Zonation
Quadrat
Transect
Classification terms (e.g., Kingdom, Phylum, etc.)
Cloud types
Beaufort scale
Sessile
Abiotic
Biotic
Invertebrate

Rocky Shore Vocab List – Definitions

Intertidal – the area on a beach between the low tide line and the high tide line, which is covered by water at high tide and exposed to air at low tide.

Tidepool – a pool of water that is left behind and/or trapped by the rocks as water falls to the low tide line. These pools provide a place of refuge for organisms that are exposed to air during low tide.

Evaporation – the process by which water changes phase, becoming a gas or vapor. This process requires heat energy. Example: when the sun heats up the water in a tidepool, the water evaporates.

Salinity – the content of dissolved salts contained in a solution; saltiness.

Temperature – a measure of hot and cold; also a measure of how fast the atoms and molecules in a substance are moving: higher temperature=faster, lower temperature=slower.

Tide – the rise and fall of sea levels caused by the gravitational forces exerted by the moon and sun and the rotation of the Earth.

Semi-diurnal – this describes the tidal cycle in New England, which experiences two, nearly equal high tides and low tides per day.

Adaptation – an adjustment or modification of the traits of an organism to make them more suited to survive in a particular environment.

Elevation – the vertical distance above a referenced point. For example, in the intertidal, the high tide line is at a higher elevation than the low tide line.

Zonation – the formation of distinct zones in a habitat in which different organisms live. In the intertidal, zones form based on abiotic factors such as temperature and amount of time a particular area is submerged, and biotic factors like competition and predation. The intertidal is generally divided into 3 zones. The low zone is dominated by red algae, sea stars and sea squirts. The mid zone is home to large canopies of brown algae which provides a home for crabs, periwinkles and other organisms. The high zone is dominated by barnacles which can survive the harsh conditions by trapping water in their shell. For illustration see the Rocky Shore Zonation Diagram provided in the Appendix.

Quadrat – a square constructed out of PVC or other materials that is used by scientists to count the number of organisms in a habitat. It would be very time consuming to count all the organisms in a habitat, so instead scientists can count the number of organisms in the quadrat, and use this number to estimate the density (#per area) of the organisms.

Transect – a large tape measure, used by scientists to avoid biased sampling. The tape is stretched out and then scientists place quadrats down at random numbers along the tape and collect data in these location.

Classification terms – Scientists use a method known as Taxonomy to classify organisms based on their morphology (physical characteristics) and their genetic relatedness. In this hierarchical system, organisms are divided into Kingdoms, then Phyla within Kingdoms, then Classes within Phyla etc. The terms are: Kingdom, Phylum, Class, Order, Family, Genus, and Species. You can use a rhyme to remember the terms and their order, such as: King Phillip Came Over For Good Spaghetti.

Cloud types:

- **Stratus** – thin flat layer in the sky, can occur at any level, Ex. Altostratus are mid-level stratus clouds.
- **Cirrus** – wisps that look like curls of hair, usually located high in the sky.
- **Cumulous** – large puffy heap of clouds
- **Nimbus** – dark rain clouds

Beaufort scale – a measure of wind speed on a scale of 1-12, based on observed conditions on land or at sea.

Sessile – non-moving. The opposite of mobile. Example: barnacles, seaweed, trees etc. Used to describe organisms that live their entire lives in one location. When surveying sessile organisms scientists estimate percent cover, as opposed to counting mobile organisms.

Abiotic – pertaining to physical rather than biological processes. Examples include physical characteristics about the environment such as temperature and salinity.

Biotic – derived from living things or related to interactions between living things.

Invertebrate – an animal that lacks a vertebral column. 97% of all animal species on earth are invertebrates. Examples include: worms, insects, jellyfish, sea stars, squid

Rocky Shore Species List

Phylum	Subphylum /Class	Common name	Scientific name
Cnidaria		Frilled Anemone	*Metridium senile*
		Hydroid	Various
Mollusca	***Gastropoda***	Smooth periwinkle	*Littorina obtusata*
		Common periwinkle	*Littorina littorea*
		Rough periwinkle	*Littorina saxatilis*
		Atlantic dog whelk	*Nucella lapillus*
		Slipper snail	*Crepidula fornicata*
		Limpet	*Tectura testudinalis*
		Nudibranch	*Aeolidia Papillosa*
	Bivalvia	Blue mussel	*Mytilus edulis*
Echinodermata		Forbes sea star	*Asterias forbesi*
		Northern sea star	*Asterias vulgaris*
		Blood star	*Henricia sanguinolenta*
		Green sea urchin	*Strongylocentrotus drobachiensis*
Arthropoda	***Crustacea***	Shrimp	Various
		Green crab	*Carcinus maenas*
		Rock crab	*Cancer irroratus*
		Jonah crab	*Cancer borealis*
		Asian shore crab	*Hemigrapsus sanguineus*
		Spider crab	*Libinia emarginata*
		Long-clawed hermit crab	*Pagurus longicarpus*
		Acorn barnacle	*Semibalanus balanoides*
		Amphipod	Various
	Hexopoda	Springtails	*Anurida maritima*
Chordata		Sheath tunicate	*Botrylloides violaceus*
Porifera		Sponges	Various
Bryozoa		Bryozoans (lacy crust)	*Membranipora* spp.
Rodophyta		Irish moss	*Chondrus crispus*

(red algae)		False Irish moss	*Mastocarpus stellatus*
		Dulse	*Palmaria palmata*
		Coralline algae	*Corallina officianalis*
		Filamentous red algae	Various
		Red stain algae	*Hildenbrandia rubre*
Heterokontophyta **(brown algae)**		Rockweed	*Fucus vesiculosus*
		Knotted wrack	*Ascophyllum nodosum*
		Common kelp	*Laminaria saccarina*
		Brown crust	*Ralfsia verucosa*
Chlorophyta **(green algae)**		Sea lettuce	*Ulva lactuca*
		Gutweed	*Ulva intestinalis*
		Dead man's fingers	*Codium fragile subsp. tomentosoides*
		Filamentous green algae	Various

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ROCKY SHORE FACTS

Each day, high tide occurs _____ times and low tide occurs _____ times.

There are about _____ hours between high tide and low tide.

The tidal range in Nahant is about_____ feet

The intertidal zone is the area between _____ and _____.

A tidepool is
_____.

Name at least 4 stressors / challenges that organisms in the intertidal zone face?

1.
2.
3.
4.

List at least 3 adaptations that animals in the intertidal zone have developed to survive?

1.
2.
3.

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HISTORY AND GEOLOGY

List three (3) reasons why people come to Nahant:

1.

2.

3.

List two (2) things you saw that were used by the military

1.

2.

During what war(s) were they used?_____.

List one thing that scientists are studying at the Marine Science Center.

What is a drumlin? When were they formed? Give an example of one you saw on the tour.

The rocks in Nahant provide evidence for the Theory of _____ because they are similar to rocks from what continent?

The rocks on East Point are home to the oldest fossils of what type of organisms (Hint: they are just like some of the animals on the rocky beach)?

List two things you saw that are used by migrating birds.

1.

2.

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Rocky Shore Facts KEY

Each day, high tide occurs ___2___ times and low tide occurs __2___ times.

There are about ___6___ hours between high tide and low tide. (6h12m, the extra 12m adds up to about 45 minutes per day, so each day low tide will be 45 minutes later than it was the day before)

The tidal range in Nahant is about_____8-12_____ feet (Average is about 10ft, Neap tides create a smaller tidal range closer to 8 and Spring tides create larger tidal range closer to 12)

The intertidal zone is the area between _____low tide_____ and _____high tide_____.

A tidepool is
A puddle of water that is trapped in the rocks during low tide. Many marine animals seek shelter in these until the water covers them again at high tide.

Name at least 4 stressors / challenges that organisms in the intertidal zone face

ABIOTIC FACTORS	**BIOTIC INTERACTIONS**
Desiccation	Competition for: food, space, dissolved O2, mates
Changes in salinity	Predation
Changes in temperature	
Wave action	

List at least 3 adaptations that animals in the intertidal zone have developed to survive?

1.**Hard shell**: helps organisms trap water to keep from drying out, protects them from predators and wave action. Shell color can even play a role in helping an animal maintain its temperature
2.**Sticking to rocks**: this helps organisms avoid predation and stay in one place to avoid getting washed away from the intertidal zone by waves. Examples: tube feet in sea stars, byssal threads in mussels, the muscular foot of a snail or limpet.
3.**Camoflage**: many organisms are the same color as the rocks or seaweed, which allows them to hide from predators.
4. **Defenses** like spines (sea urchin), claws (crabs, lobster) and stinging cells (anemones) to avoid predators and compete for food.

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HISTORY AND GEOLOGY KEY

List three (3) reasons why people come to Nahant:
1. Aesthetic beauty/recreation/vacation
2. Science/Research: to study the ocean and the rocks
3. Defense: strategic military location

List two (2) things you saw that were used by the military
1. 3 military bunkers
2. Triangulation towers
3. Nike Missile Silo (under the hill now)
4. Remnants of the submarine detection building

During what war(s) were they used? WWII, Cold War (Nike Missile Silo only)

List one thing that scientists are studying at the Marine Science Center.
Invasive species, fisheries (lobster, cod, oyster), climate change, biodiversity loss, lobster brains, how predators scare their prey

What is a drumlin? When were they formed? Give an example of one you saw on the tour.
A drumlin is a hill formed when retreating glaciers moved rocks and soil during the last ice age. The Boston Harbor Islands are drumlins, and they are special because they are one of only two drowned drumlin fields (meaning they are mostly covered with water) in the world. The other is off the coast of Ireland.

The rocks in Nahant provide evidence for the Theory of ___Pangea___ because they are similar to rocks from what continent? Africa

The rocks on East Point are home to the oldest fossils of what type of organisms (Hint: they are just like some of the animals on the rocky beach)?
Shelled animals similar to molluscs (snails, mussels, limpets)

List two things you saw that are used by migrating birds.
1. Tall grass: certain portions are kept long so that migrating birds can stop and rest.
2. Egg rock: only birds live there, so it is safe from predators that live on the mainland.
3. Birdhouses

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PRACTICE QUADRATS

Today's date _____
Team members _____

Algae species

Phylum/Class	Common name	% Cover
Yarn	Green	
	Maroon	
	Beige	
	Other _____	
Pipecleaners	White	
	Red	
	Yellow	
	Green	
	Other _____	
Felt	Green	
	Beige	
	Maroon	
	Other _____	

Animal species

Phylum/Class	Common name	Number
Pom-Poms	Dark green	
	Light green	
	Red	
	Purple	
	Pink	
	Yellow	
	Blue	
	White	
	Other _____	
Snails	Gray	
	White	
	Yellow	
	Other _____	
Other	Other _____	
	Other _____	
	Other _____	

WEATHER OBSERVATIONS

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Today's Date: _____

Group members: _____

Weather (circle one)

Sunny Partly Cloudy Mostly Cloudy Overcast Rainy

Use the chart to identify the cloud types in the sky and write them here:

_____

Estimate the wind speed (circle one)

<5 mph 1-5 mph 6-10 mph 11-20 mph > 20 mph

Estimate the wind speed using the Beaufort scale (circle one)

0 1 2 3 4 5 6 7 8 9 10 11 12

Air temperature _____ °F *(sit thermometer in shade for at least 30 seconds)*

CREATE A ROCKY SHORE FOOD WEB

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Name: _____ **Date:** _____

1. Use the list of living things below and pyramid to make a diagram showing who eats whom on the rocky shore.

2. Work together with your classmates and use resources like textbooks or the Internet to determine if each organism is a primary producer, primary consumer, second level consumer or third level consumer and what it eats or gets eaten by.

3. Write the name or draw a picture of each rocky shore critter on the food web pyramid.

4. Next draw arrows up the food web from who gets eaten, to who eats it

   Example: snail→ crab, because the crab eats the snail.

   Remember that since this is a food web, not a food chain, organisms can eat more than one and get eaten by more than one thing, allowing for many arrows

Organisms on the rocky shore

Snail
Crab
Sea gull
Barnacle
Sea urchin
Phytoplankton
Seaweed
Sea star
Blue mussel
Zooplankton

Once you have created your food web, answer the following questions:

1. Why do the arrows point from something that gets eaten to something that eats it? What does the predator/herbivore get from its prey?

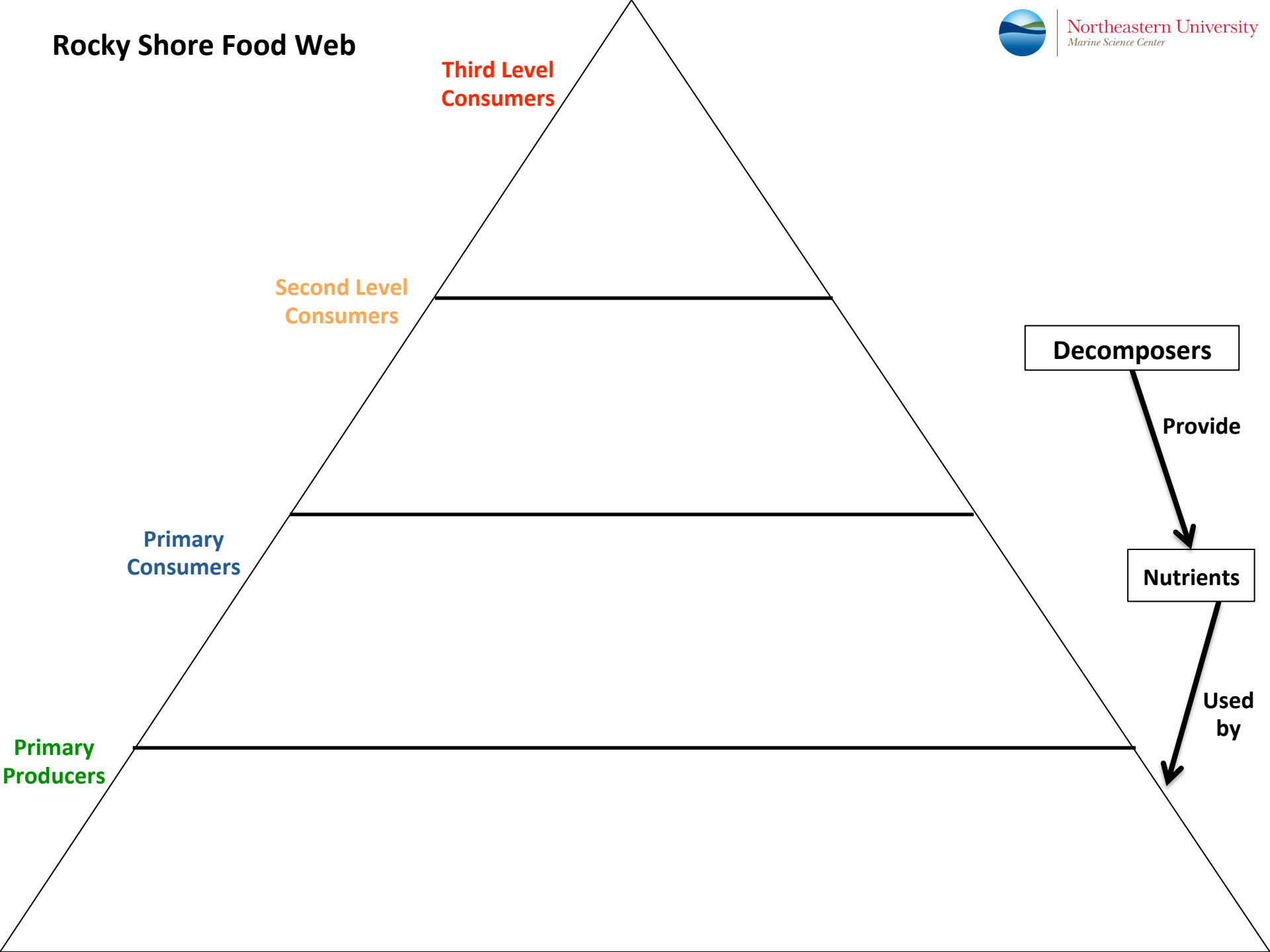
Arrow=_____

(Please Turn Over ➔)

2. Why is the food web shaped like a pyramid? Why are bottom levels (primary producers and primary consumers) larger than the higher levels (secondary consumers and tertiary consumers)?

3. Decomposers complete the food web by breaking down organic material (such as dead plants and animals) and convert it into nutrients, which are used by primary producers. Go back to your food web and draw arrows from food web levels (such as primary producers, secondary consumers) to the decomposers that show which levels provide organic material for decomposers to break down. (Hint: you should draw more than just one arrow).

Rocky Shore Food Web



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Rocky Shore Food Web

Tertiary Consumers
Secondary Consumers
Primary Consumers
Primary Producers

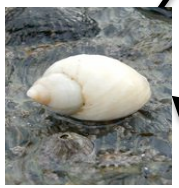

Sea Gull


Sea star


Rock Crab


Green crab


Nudibranch


Dog whelk


Smooth Periwinkle


Sea urchin

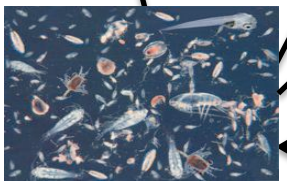

Barnacle

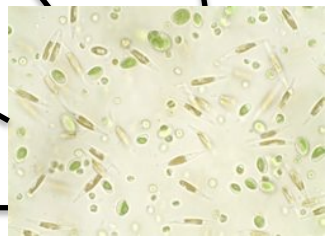

Sea anemone


Blue mussel


Limpet


Seaweed


Zooplankton


Phytoplankton

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Construct a Field Guide

Organism Name:_____

Habitat: _____

Interesting fact about this organism: _____

_____

_____

Draw the organism or paste a picture of the organism in this box:

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A Guide to the Rocky Intertidal: Arthropods

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Asian Shore Crab
Hemigrapsus sanguineous

Green Crab
Carcinus maenas

Long Clawed Hermit Crab
Pagurus longicarpus

Jonah Crab
Cancer borealis

Acorn Barnacle
Semibalanus balanoides

Rock Crab
Cancer irroratus

American Lobster
Homarus americanus

Spider Crab
Libinia emarginata

European Rock Shrimp
Palaemon elegans

Amphipod
various

Arthropods

A Guide to the Rocky Intertidal: Mollusks

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Rough Periwinkle
Littorina saxatilis

Common Periwinkle
Littorina littorea

Blue Mussel
Mytilus edulis

Lady Slipper Snail
Crepidula fornicata

Smooth Periwinkle
Littorina obtusata

Atlantic Dog Whelk
Nucella lapillus

Atlantic Plate Limpet
Tectura testudinalis

Moon Snail
Lunatia heros

Nudibranch
Aeolidia Papillosa

Mollusks

A Guide to the Rocky Intertidal: Algae

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Dulse
Palmaria palmata

Red Stain Algae
Hildenbrandia rubra

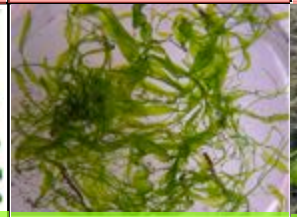
Filamentous Red Algae
various

Coralline algae
various

Irish Moss
Chondrus crispus

Kelp
Laminaria spp.

Dead Man's Fingers
Codium fragile



Gut Weed
Ulva intestinalis

Filamentous Green Algae
various

Sea Lettuce
Ulva lactuca

Rockweed
Fucus vesiculosis

Knotted Wrack
Ascophyllum nodosum

Algae

A Guide to the Rocky Intertidal: Echinoderms, etc.

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Forbes Sea Star
Asterias forbesi

Blood Star
Henricia sanguinolenta

Green Sea Urchin
Strongylocentrotus drobachiensis

Crusting Bryozoan
Membranipora spp.

Stalked Hydroid
Dynamena pumila

Sheath Tunicate
Botrylloides violaceus

Springtails
Anurida maritima

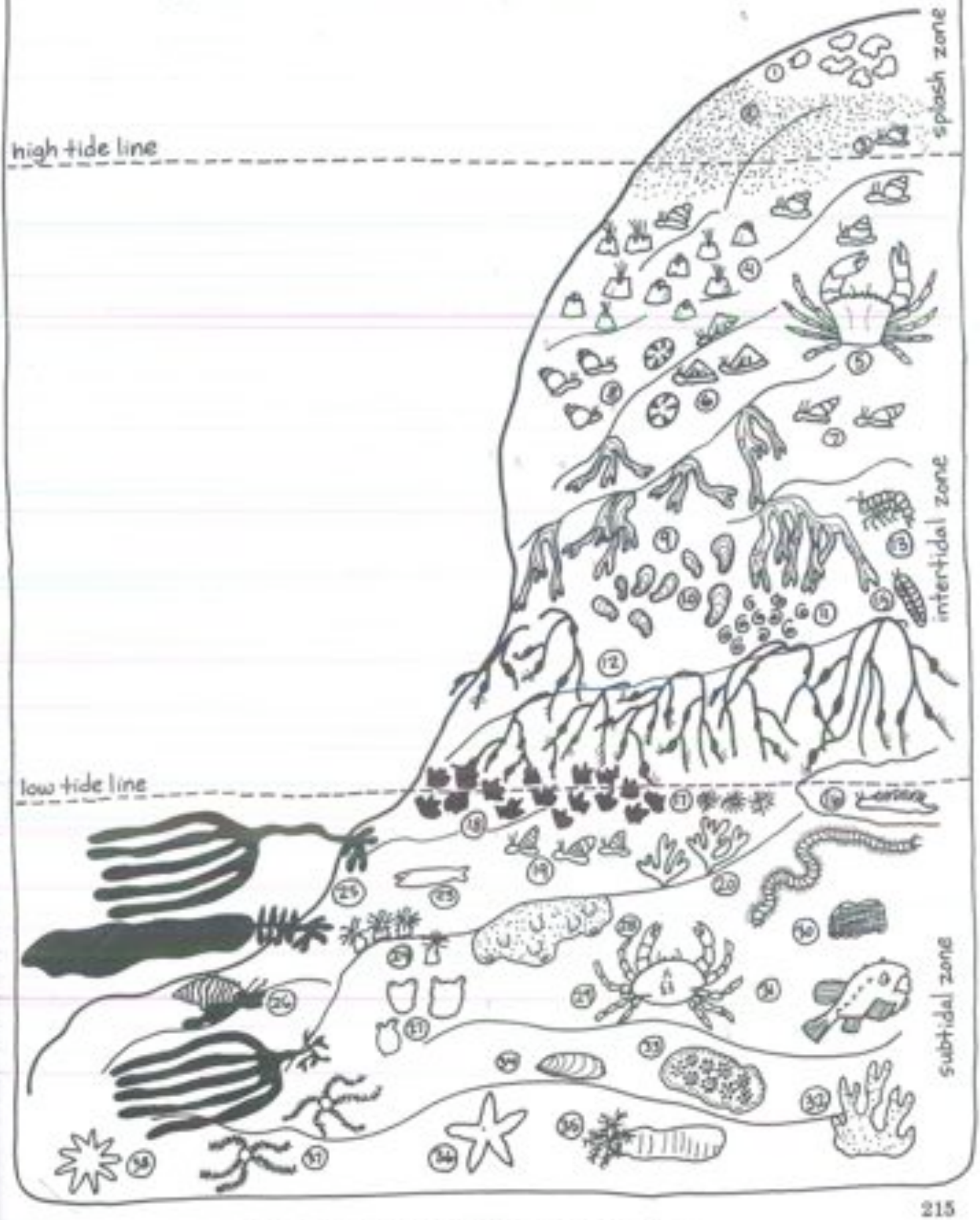
Anemone
various

Cormorant
Phalacrocorax auritus

Rock Gunnel
Pholis gunnellus

Echinoderms, etc.

Rocky Shore Community



The Seaside Naturalist. Deborah A. Coolombe. Fireside Publishing. 1984

For organisms living in the rocky intertidal zone, life is a constant challenge. As the tide comes in, or when storms occur, the intertidal organisms are hit by crushing waves. When the tide recedes, they are left high and dry. Basins among the rocks trap water from the outgoing tide, and these tidepools remain until covered by the next high tide. Organisms in tidepools must deal with extreme fluctuations in temperature, salinity, and oxygen availability. Because of their differing abilities to live out of the water, intertidal organisms appear in specific horizontal bands along the shore. Others that live near or below the low tide line can only stand to be exposed to the air for very short periods of time.

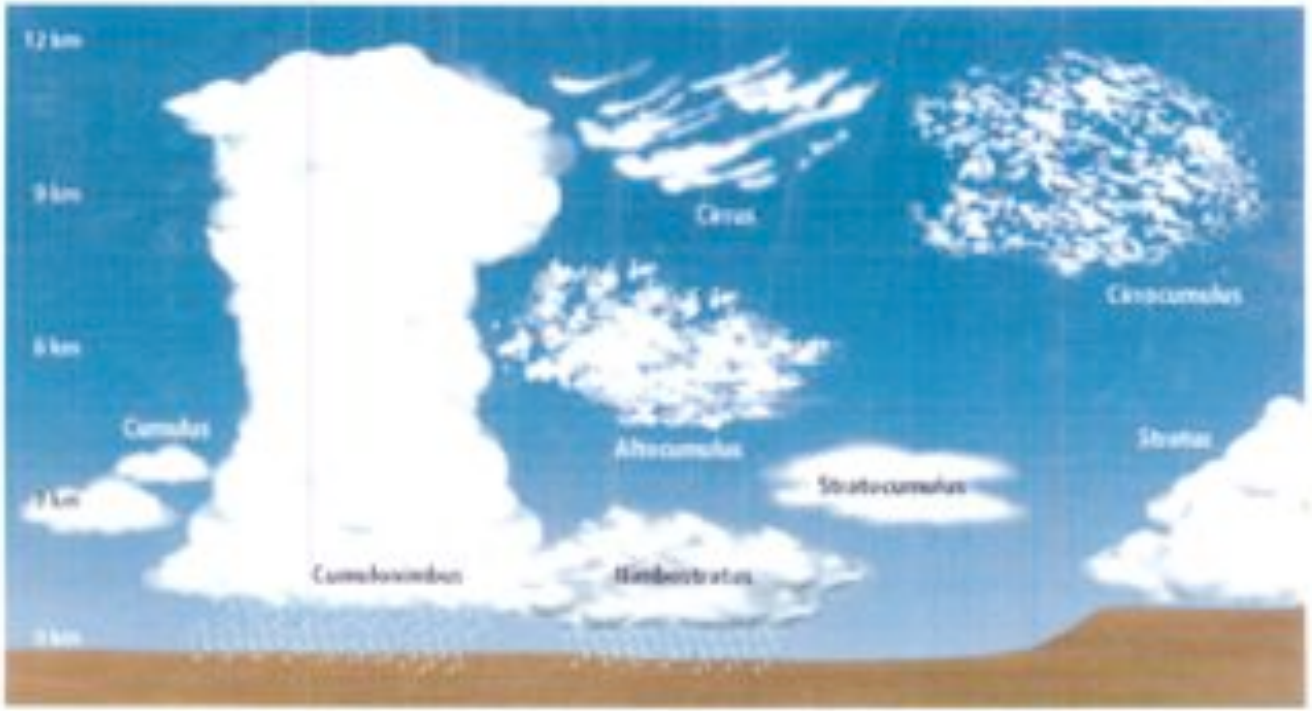
The following list corresponds to the organisms shown on page 215.

1. marine lichens	*Xanthoria, Verrucaria*
2. blue-green algae	*Calothrix*
3. Rough periwinkle	*Littorina saxatalis*
4. Acorn barnacle	*Balanus balanoides*
5. Green crab	*Carcinus maenas*
6. Atlantic plate limpet	*Acmaea testudinalis*
7. Atlantic dog whelk	*Thais lapillus*
8. Common periwinkle	*Littorina littorea*
9. Rockweed	*Fucus vesiculosus*
10. Blue mussels	*Mytilus edulis*
11. Coiled spiral worms	*Spirorbis borealis*
12. Knotted wrack	*Ascophyllum nodosum*
13. beach hopper	*Gammarus*
14. Northern red chiton	*Isochiton ruber*
15. Twelve-scale worm	*Lepidonotus squamatus*
16. Red-gilled nudibranch	*Coryphella verrucosa*
17. Green sea urchin	*Strongylocentrotus droabachiensis*
18. Irish moss	*Chondrus crispus*
19. Smooth periwinkle	*Littorina obtusata*
20. Dulse	*Palmaria palmata*
21. Clam worm	*Nereis virens*
22. Sea lettuce	*Ulva lactuca*
23. Rock eel	*Pholis gunnellus*
24. Frilled sea anemone	*Metridium senile*
25. kelps	*Alaria, Laminaria*
26. New England neptune	*Neptunea decemcostata*
27. sea squirts	*Molgula, Boltenia, Ciona*
28. Bread crumb sponge	*Halichondria panicea*
29. Rock crab	*Cancer irroratus*
30. sea lace	*Electra, Membranipora*
31. Lumpfish	*Cyclopterus lumpus*
32. Dead man's finger sponge	*Halichona oculata*
33. Star tunicate	*Botryllus*
34. Eastern white slipper shell	*Crepidula fornicata*
35. Orange-footed sea cucumber	*Cucumaria frondosa*
36. Sea star	*Asterias*
37. Daisy brittle star	*Ophiopholis aculeata*
38. Spiny sunstar	*Crossaster papposus*

The Seaside Naturalist. Deborah A. Coulombe. Fireside Publishing. 1984

Cloud Types

Cirro-means 'high-level'
Cirrostratus clouds are more like a thin veil high in the sky
Cirrocumulus clouds are layered with little lumps
Cirrus clouds are thin and wispy and made of ice crystals
Alto- means 'mid-level'
Altostratus clouds are flat and may thicken and lower into rain or snow
Altocumulus clouds are heaped up and may form rows
Stratus clouds are flat and make a low gray layer of clouds that may cause light rain
Stratocumulus clouds form a layer of cloud lumps with thick and thin areas
Nimbus-mean 'rain or snow'
Cumulonimbus clouds produce large storms



Beaufort Scale

Beaufort Scale	Description	Feels like/looks like:
0	Calm; wind less than 1 mph, water is flat.	Calm, smoke rises straight up
1	Light air; wind 1-3 mph, water has ripples without crests.	Smoke drifts in direction of wind
2	Light breeze; wind 4-7 mph, water has small wavelets, glassy crests, not breaking	Wind felt on skin, leaves rustle.
3	Gentle breeze; wind 8-12 mph, water has large wavelets, scattered whitecaps and crests begin to break	Leaves and small twigs constantly moving, flags fluttering.
4	Moderate breeze; wind 13-17 mph, water has small waves with breaking crests, whitecaps.	Dust blowing, small branches start moving.
5	Fresh breeze; wind 18-24 mph, water has moderate waves, many whitecaps, a little spray.	Medium sized branches move, small trees start to sway.
6	Strong breeze; wind 25-30 mph, watef has many white foam crests, some airborne spray.	Large branches move, wires whistle, umbrellas are hard to use.
7	High wind; wind 31-38 mph, water heaps up, foam from breaking waves blown in streaks along wind direction, moderate airborne spray.	Whole trees moving, hard to walk against the wind.
8	Gale; wind 39-46 mph, Moderately high waves, well-marked streaks of foam in wind direction, considerable airborne spray	Twigs breaking off of trees, cars swerve from wind, can't walk against wind.
9	Strong gale; wind 47-54 mph, water has high waves whose crests sometimes roll, dense foam, spray may reduce visibility.	Some branches break off trees, small trees blow over, traffic cones blow over.
10	Storm; wind 55-63 mph, water has very high waves, large patches of foam make sea look white, spray reduces visibility.	Trees are broken or uprooted, shingles on roofs peel off and blow away.
11	Violent storm; wind 64-72 mph, water has exceptionally high waves, very large patches of foam cover most of sea surface, poor visibility from spray.	Lots of damage to plants, many roofs damaged.
12	Hurricane; wind greater than 73 mph, hugh waves, sea completely white, air filled with spray.	Lots of damage to plants, windows break, flying debris.


Nahant Bay
Egg Rock
Lodge Park
Nahant Harbor
Marine Science Center