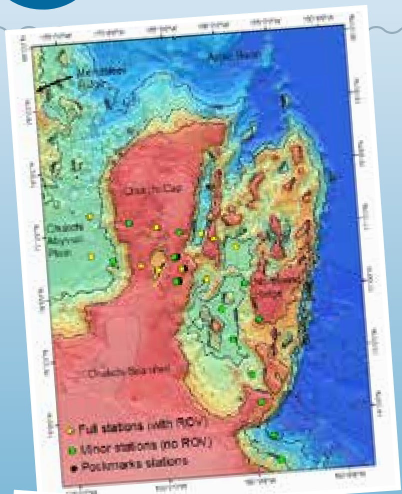
Ocean Exploration and Research

Hidden Ocean Expedition 2016: Chukchi Borderlands

Just Jelly

(adapted from the 2005 Hidden Ocean Expedition)



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lesson plan

Focus
Gelatinous zooplankton in the Chukchi Borderlands

Grade Level
9-12 (Life Science)

Focus Question
What are the common gelatinous zooplankton in the Chukchi Borderlands environment, and what are their ecological roles?

Learning Objectives
- Students compare and contrast the feeding strategies of at least three different types of gelatinous zooplankton.
- Students explain why gelatinous zooplankton may function at several trophic levels within a marine food web.
- Given information on the vertical distribution of temperature in a water column, students make inferences about potential influences on the distribution of planktonic species in the water column.

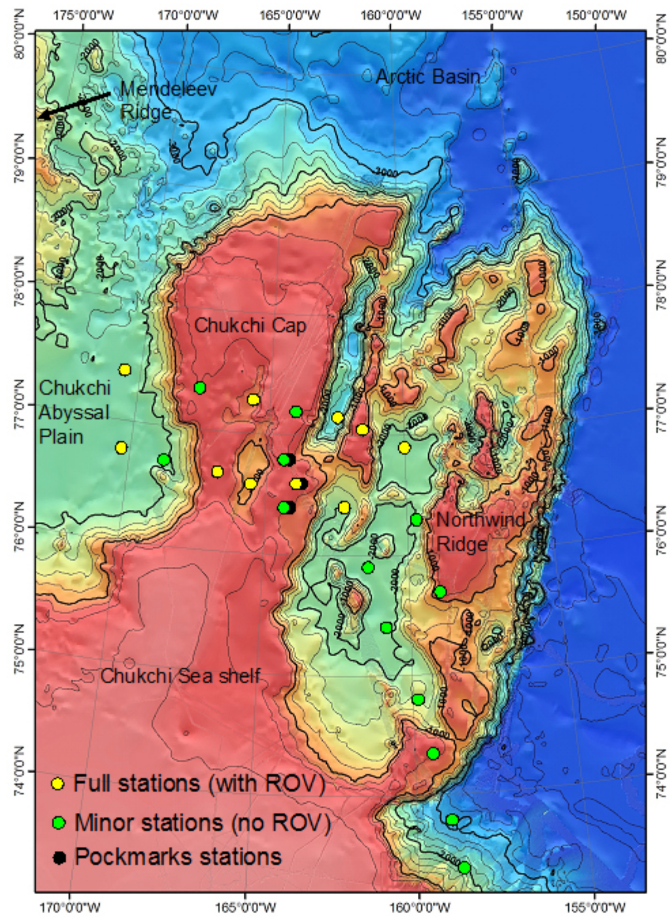
Materials
- ❑ Copies of *Observations on Arctic Gelatinous Zooplankton* and *Analysis Guide for Observations on Arctic Gelatinous Zooplankton*, one copy of each for each student

Audio-Visual Materials
None

Teaching Time
One or two 45-minute class periods, plus time for student analysis

Seating Arrangement
Classroom style

Maximum Number of Students
30



Bathymetry of Chukchi Borderlands with tentative stations positions. Image courtesy M. Edwards, University of Hawaii.

Key Words

Pelagic realm
Benthic realm
Sea ice realm
Gelatinous zooplankton
Cnidaria
Ctenophora
Chaetognatha
Larvacea
Arctic Ocean
Chukchi Sea

Background Information

NOTE: Explanations and procedures in this lesson are written at a level appropriate to professional educators. In presenting and discussing this material with students, educators may need to adapt the language and instructional approach to styles that are best suited to specific student groups.

The Arctic Ocean is the most inaccessible and poorly studied of all the Earth's major oceans, and is the area that may experience the greatest impact from climate change. The Chukchi Borderlands (CBL) to the north of Alaska is one of the Arctic's least-explored and most rapidly changing regions. The topographic complexity of this region, which includes ridges, canyon, abyssal trenches, and shallow plateaus, suggests that there may be a similar variety of biological communities; but very little exploration has taken place to confirm this suggestion. The need for such exploration is urgent, because the rapid rate of environmental change within the CBL makes it likely that the region's biological communities will change as well. Exploring CBL biological communities is the purpose of the Hidden Ocean Expedition 2016: Chukchi Borderlands Expedition (*http://oceanexplorer.noaa.gov/explorations/16arctic/welcome.html*).

CBL biological communities are tightly linked to each other and occur in three distinct environments:

- The Benthic Realm, which is composed of organisms that live on the bottom, including sponges, bivalves, crustaceans, polychaete worms, sea anemones, bryozoans, and tunicates;

Images from Page 1 top to bottom:
Bathymetry of Chukchi Borderlands with tentative stations positions. Image courtesy M. Edwards, University of Hawaii.

Sea ice extent in the Arctic in April 2014. Image courtesy of the National Snow and Ice Data Center.
http://oceanexplorer.noaa.gov/explorations/15arctic-microbes/background/seaice/seaice.html

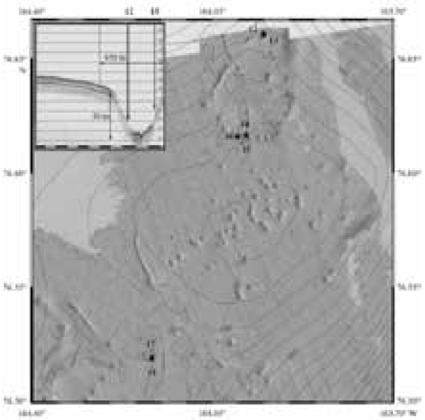
Single-celled (unicellular) algae, which develop in the lowermost sections of sea ice, often form chains and filaments. Ice algae are an important component of the Arctic marine food web. Image courtesy of the NOAA Arctic Research Program.
http://oceanexplorer.noaa.gov/explorations/15arctic-microbes/background/missionplan/media/arctic-algae.html

In 2005, NOAA explorers discovered the reproductive mode for the deep-water copepod *Euaugaptilus hyperboreus*. Image courtesy of the The Hidden Ocean Arctic 2005 Expedition.

- The Pelagic Realm, which includes organisms that live in the water column between the ocean surface and the bottom; and
- The Sea Ice Realm, which includes plants and animals the live on, in, and just under the ice that floats on the ocean's surface.

The Chukchi Borderlands Expedition uses an integrated ecosystem strategy that includes three components, each of which is focused on one of these realms.

The **Unexplored Seafloor Community** component focuses on the benthic realm. Benthic invertebrate and fish fauna will be collected with a combination of corer, trawl, and remotely operated vehicle (ROV) techniques. Collected specimens will be identified with standard morphological techniques, as well as DNA sequencing. These techniques will allow explorers to look for relationships between CBL fauna and organisms found on the Chukchi shelf and adjacent deep-sea environments. An important part of this component is to improve understanding of trophic relationships between benthic organisms, bottom-feeding fishes, and higher trophic levels such as marine mammals. This component also includes investigations of unusual bottom features called "pockmarks," which are craters ranging in size from less than one meter to over 100 meters in diameter. Pockmarks are typically formed by seeping sulfur or carbon compounds, which provide specialized habitats for organisms that are able to tolerate and utilize seep fluids that are toxic to many other species.



Bottom topography of a pockmark field in the Chukchi Borderlands. The insert shows a distinct depression in the bottom profile of pockmark crater #12. Image courtesy Astakhov *et al.* 2014.

The **Navigating the Hidden Microbial Network in Sea Ice** component focuses on the sea ice realm. Sea ice provides a complex habitat for many species that are called sympagic, which means "ice-associated." The ice is riddled with a network of tunnels called brine channels that range in size from microscopic (a few thousandths of a millimeter) to more than an inch in diameter. Diatoms and algae inhabit these channels and obtain energy from sunlight to produce biological material through photosynthesis. Bacteria, viruses, and fungi also inhabit the channels, and together with diatoms and algae provide an energy source (food) for flatworms, crustaceans, and other animals.

Sterilely sectioning a sea ice core in Franklin Bay, Canada. Image courtesy of Eric Collins.
http://oceanexplorer.noaa.gov/explorations/15arctic-microbes/background/seaice/media/core.html

The basic method is as follows:
1) collect sea ice cores using a specialized ice auger;
2) cut the ice into 6 in (10 cm) sections;
3) melt the ice;
4) pump the melted ice through a filter to collect the microbes;
5) extract DNA from the filters; and
6) sequence the DNA to determine the diversity of genes and organisms in the ice.

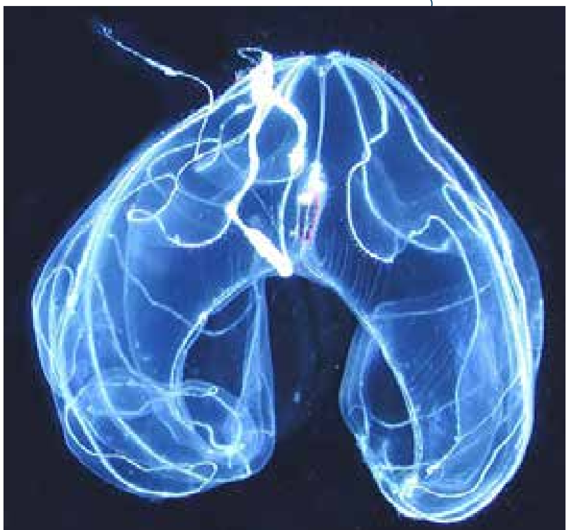
Fishing for microbes in the Chukchi Sea. Image courtesy of the Mapping the Uncharted Diversity of Arctic Marine Microbes expedition.
http://oceanexplorer.noaa.gov/explorations/15arctic-microbes/logs/january11/media/fig2.html

Vacuum pump apparatus for cleaning up and isolating genetic material. Image courtesy of the Mapping the Uncharted Diversity of Arctic Marine Microbes expedition.
http://oceanexplorer.noaa.gov/explorations/15arctic-microbes/logs/january11/media/fig4-hires.jpg

In the spring, melting ice releases organisms and nutrients that interact with the ocean water below the ice. Large masses of algae form at the ice-seawater interface and grow rapidly since the sun shines for 24 hours a day during the summer. On average, more than 50% of the primary production in the Arctic Ocean comes from single-celled algae that live near the ice-seawater junction. This interface is critical to the polar marine ecosystem, providing food for many organisms, as well as protection from predators. Sharp declines in the extent of Arctic sea ice since 2007 may have serious consequences for pelagic and benthic Arctic realms if these declines reduce the amount of sea ice-produced organic matter available to these realms. In particular, the loss of organic detritus from sea ice algae may have major nutritional impacts on primary and secondary consumers.

The **Exploration of Pelagic Life in a Complex Polar Environment** component focuses on the pelagic realm. Many pelagic species are floating organisms collectively known as zooplankton, including floating crustaceans, jellyfishes, and larvae of many species. Studies of zooplankton are traditionally biased to organisms that can be captured by plankton nets, usually in waters shallower than 200 m. This bias excludes many fragile species as well as those that are able to avoid plankton nets. Very little is known about the ecology and distribution of gelatinous zooplankton such as ctenophores, siphonophores, hydromedusae, and scyphomedusae. Deepwater gelatinous zooplankton are an important part of the global carbon cycle, because they are constantly grazing and re-processing carbon produced by photosynthesis in shallower water. Moreover, most gelatinous zooplankton are the dominant predators of smaller zooplankton species and juveniles of many fish species. Larvaceans are another group of gelatinous zooplankton that graze phytoplankton by filter feeding. Because larvaceans grow rapidly and are efficient grazers, they can have a significant impact on the amount of phytoplankton that reaches the benthic realm. The potential impacts on prey species as well as on the flow of phytoplankton between realms are both good examples of why better understanding of gelatinous zooplankton is essential to understanding the interactions between CBL marine ecosystems.

ROV Global Explorer will be used for both pelagic and benthic work. Equipped with new 4K cameras, this ROV will yield ultra-high-definition quality imaging of in situ habitats and communities, plus specimen collection capabilities essential for the discovery of delicate pelagic and benthic species. Image courtesy Deep Sea Systems.



This is an example of a ctenophore, *Bathocyroe fosteri*, which is a mesopelagic species. Image courtesy of Arctic Exploration 2002, Marsh Youngbluth, NOAA/OER.
http://oceanexplorer.noaa.gov/explorations/02arctic/background/fauna/media/cteno.html

Kevin Raskoff labels a specialized piece of paper containing a new species of jellyfish. The chemicals on the paper dehydrate the organism and make DNA analysis easier. Image courtesy of The Hidden Ocean, Arctic 2005 Exploration, NOAA-OE.
http://oceanexplorer.noaa.gov/explorations/05arctic/logs/july5/media/raskoff_labels.html

In recent years, underwater vehicles have significantly improved ocean explorers' abilities to study gelatinous zooplankton. In particular, high definition video, tools that can capture live zooplankton, and deepwater capabilities have made it possible to study organisms that cannot be sampled with traditional methods. Previous Ocean Explorer expeditions to the Canada Basin found large numbers of gelatinous zooplankton, including species that were previously unknown to science. Direct visual observation capabilities also revealed that other pelagic species such as octopods and squid are abundant, though there was virtually no previous record of their existence in this region. The primary objective of this component is to inventory pelagic species including deepwater and gelatinous zooplankton, and to establish DNA libraries of these species.

To include species usually excluded by traditional sampling methods, explorers will use photographic and video documentation of living animals accompanied by collection of representative specimens. In addition, traditional plankton net samples will also be collected for comparison with observations and collections made with the Expedition's ROV. At some sites, the latter observations and collections will span the entire water column to determine the depth distribution of various gelatinous zooplankton species. In addition to ultra-high definition video, live zooplankton will be photographed in special tanks using multiple cameras to obtain three-dimensional images that show internal structures important to species identification. Samples of collected organisms will also be used for metagenetic analysis, a technique that compares short sequences of DNA to estimate biodiversity and identify species.

In this lesson, students will analyze data from a previous Ocean Explorer expedition to draw inferences about interactions between gelatinous zooplankton species in Arctic ecosystems.

Learning Procedure

1. To prepare for this lesson:
   a. Review background information about the Hidden Ocean Expedition 2016: Chukchi Borderlands [*http://oceanexplorer.noaa.gov/explorations/16arctic/welcome.html*]
   b. You may also want to review "Spineless Wonders II: The Pelagic Fauna" by Russ Hopcroft [*http://oceanexplorer.*

noaa.gov/explorations/05arctic/background/fauna/fauna.html] from the Hidden Ocean, Arctic 2005 Expedition:

2. Briefly review the geography of the Arctic Ocean, highlighting the location of the Chukchi Borderlands and its relationship to the Arctic and Pacific Oceans. Introduce the three realms of marine life in the Chukchi Borderlands. You may also want to briefly discuss Arctic climate change and why it is so important to gather information on species that presently inhabit the three realms as soon as possible.

3. Provide each student with a copy of *Observations on Arctic Gelatinous Zooplankton*. Tell students that their assignment is to analyze these data as necessary to answer the questions on the *Analysis Guide*. Depending upon their knowledge of the invertebrate groups represented, students may also need to do some additional research to develop plausible answers to these questions. If students are not familiar with logarithmic graph scales, you may want to refer them to the tutorial at *http://www.physics.uoguelph.ca/tutorials/GLP/* or copy these materials for student use.

4. Lead a discussion of students' answers to questions on the *Analysis Guide*.
   • There are a variety of factors that may limit the vertical distribution of pelagic species, and it is plausible that one or more physical factors (*e.g*, temperature, salinity, pressure) may be limiting to any of these organisms. Students should also recognize, however, that except for the larvaceans, all of these organisms are active predators, and are also confined to areas where they can find suitable prey. Animals that primarily consume herbivorous zooplankton may thus be confined to shallow water were light penetration is adequate for photosynthesis.

   • Cnidarians (hydromedusae, scyphozoans and siphonophores), ctenophores, chaetognaths, and larvaceans have distinctly different feeding strategies: Cnidarians dangle tentacles armed with stinging cells (nematocysts or cnidocysts) that paralyze animals that blunder into the tentacles; Ctenophores have lobes or tentacles containing sticky cells (colloblasts) that adhere to prey organisms; Chaetognaths have a series of movable spines on their head which are used to capture food, and are more active hunters of prey organisms than the other groups; and Larvaceans have a complex and highly efficient filtering apparatus that can capture particles as small as one micron. The ability to feed on very small particles of organic material may make the larvaceans less dependent upon particular types of prey organisms than the other three groups.

- Since the groups of gelatinous zooplankton represented in the table employ a variety of feeding strategies, it is likely that they feed on a variety of materials that might include herbivores, secondary or tertiary carnivores, microscopic organisms, and particulate organic matter. These materials would inevitably be derived from several trophic levels, and for this reason it is likely that there would be corresponding differences in nitrogen isotope ratios. You may want to ask students to identify a mathematical representation that would be appropriate to describe the flow of energy among organisms in the pelagic ecosystem. The classic assumption is that ecological efficiency is about 10% from one trophic level to the next (*i.e.*, 10% of the energy available in one trophic level is transferred to the next-highest trophic level), but the 1:10 ratio may be different if organisms are feeding at more than one trophic level.

- The life cycle of many cnidarians, including Scyphozoa, includes a jellyfish-like stage (called a medusa) as well as an anemone-like stage (called a polyp). The Scyphozoan specimens in the core samples were the polyp stage of these cnidarians.

- Students' graphs of water temperature vs. depth should indicate a minimum temperature at about 150 meters and a maximum temperature at about 500 meters. While there are many hypotheses that might account for the temperature profile documented by data in Table 1, the hint should lead students to consider the influence of the neighboring Arctic and North Pacific Oceans. The CBL is generally regarded as a complex of several water masses. The upper 25 m known as the Mixed Zone consists of near-surface waters that are well-mixed with fairly uniform temperature, and are strongly influenced by sea water freezing and ice melting. Below the Mixed Zone, temperature increases to a depth of about 40 m where Pacific waters show a steady decrease to the minimum temperature at about 160 - 180 m.

The existence of these distinct water masses could affect distribution of gelatinous zooplankton in several ways. The most obvious is temperature itself as predator or prey species with specific temperature requirements would be confined to those portions of the water column with suitable temperatures. Nutrient content might also vary in waters from different sources, which in turn influence primary production by phytoplankton and the production of herbivorous prey species for gelatinous predators. In addition, density differences between different water masses create convergences where these masses meet, and there are many examples of high densities of gelatinous species at these convergences.

- The primary obstacle to detailed observations and research on gelatinous zooplankton has been the fragility of these species, and their transparency. Since these organisms were usually seen only as mangled "jelly" in sampling nets, or not seen at all, it is not surprising that information is scarce. What should be surprising, though, is that this absence of data led some to conclude that these species were unimportant in the food web. This is a good example of how applying new technology in unexplored areas can reveal key ecosystem components that have been previously ignored or not known at all.

The BRIDGE Connection

www.vims.edu/bridge/ – Mouse over "Ocean Science Topics," then "Habitats," then "Polar" to find links to information and activities concerning the Arctic region.

The "Me" Connection

Have students write a brief essay describing an example of how new information about an organism or process that presently appears insignificant might reveal unexpected importance and personal relevance.

Connections to Other Subjects

English/Language Arts, Geography, Physical Science

Assessment

Student reports prepared in Learning Procedure Step 3 and the group discussion in Step 4 provide opportunities for assessment.

Extensions

1. Have students visit [*http://oceanexplorer.noaa.gov/explorations/16arctic/welcome.html*] to keep up to date with the latest Hidden Ocean Expedition 2016: Chukchi Borderlands discoveries.

2. Visit *http://oceanexplorer.noaa.gov/explorations/02arctic/background/education/education.html* and *http://oceanexplorer.noaa.gov/explorations/05arctic/background/edu/edu.html* for more lesson plans and activities related to the 2002 and 2005 Hidden Ocean expeditions.

3. Visit *http://jellieszone.com/* for more information about jellyfishes, including the deadly cubomedusae of Australia, as well as how jellyfish can be kept in aquaria (with a lot of work!).

Other Relevant Lessons from NOAA's Ocean Exploration Program

Being Productive (grades 9-12)
from the 2002 Arctic Exploration Expedition
[*http://oceanexplorer.noaa.gov/explorations/02arctic/background/education/media/arctic_productive.pdf*]

Focus: Primary productivity and limiting factors in the Arctic Ocean (Life Science)

Students identify the three realms of the Arctic Ocean, and describe the relationships between these realms; and identify major factors that limit primary productivity in the Arctic Ocean, and describe how these factors exert limiting effects. Given data on potentially limiting factors and primary productivity, students will be able to infer which factors are actually having a limiting effect.

Let's Get to the Bottom (grades 9-12)
from the 2002 Arctic Exploration Expedition
[*http://oceanexplorer.noaa.gov/explorations/02arctic/background/education/media/arctic_bottom.pdf*]

Focus: Factors that influence the composition of benthic communities in the deep Arctic Ocean (Life Science)

Students identify the three realms of the Arctic Ocean, and describe the relationships between these realms; describe different species associations in a benthic community; and infer probable feeding strategies used by benthic organisms and relate these strategies to sediment characteristics.

Message in the Bottles (grades 9-12)
from the 2002 Arctic Exploration Expedition
[*http://oceanexplorer.noaa.gov/explorations/02arctic/background/education/media/arctic_message.pdf*]

Focus: Estimating primary productivity (Earth Science/Chemistry)

Students identify the three realms of the Arctic Ocean, and describe the relationships between these realms; explain the relationships between gross primary productivity, net primary productivity, and respiration; and understand how oxygen production and consumption can be measured and used to estimate primary productivity in water bodies.

What's Eating You? (grades 9-12)
from The Hidden Ocean, Arctic 2005 Expedition
[*http://oceanexplorer.noaa.gov/explorations/05arctic/background/edu/media/05arctic_whatseating.pdf*]

Focus: Trophic relationships in Arctic marine ecosystems (Chemistry/Biology)

Students describe how ratios of stable nitrogen isotopes can be used to study trophic relationships between marine organisms, make inferences about trophic relationships between organisms and habitats, and compare and contrast organisms in sea ice, pelagic, and benthic communities in terms of feeding strategies and consequent stable nitrogen isotope ratios.

The Good the Bad and the Arctic (grades 9-12)
from The Hidden Ocean, Arctic 2005 expedition
[*http://oceanexplorer.noaa.gov/explorations/05arctic/background/edu/media/arctic05_goodandbad.pdf*]

Focus – Social, economic and environmental consequences of Arctic climate change (Biology/Earth Science)

Students identify and explain at least three lines of evidence that suggest the Arctic climate is changing, identify and discuss at least three social, three economic and three environmental consequences expected as a result of Arctic climate change, identify at least three climate-related issues of concern to Arctic indigenous peoples, and identify at least three ways in which Arctic climate change is likely to affect the rest of the Earth's ecosystems.

Other Resources

The Web links below are provided for informational purposes only. Links outside of Ocean Explorer have been checked at the time of this page's publication, but the linking sites may become outdated or non-operational over time.

[*http://oceanexplorer.noaa.gov/explorations/16arctic/welcome.html*] – Follow the Hidden Ocean Expedition 2016: Chukchi Borderlands as documentaries and discoveries are posted each day for your classroom use.

Raskoff, K. A., J. E.. Purcell, and R. R. Hopcroft. 2005. Gelatinous zooplankton of the Arctic Ocean: in situ observations under the ice. Polar Biology 28:207-217 – The technical journal article on which this lesson is based.

http://www.coml.org/arctic-ocean-dicersity-arcod – The Arctic Ocean biodiversity section of the Census of Marine Life Web site

http://www.arctic.noaa.gov/ – NOAA's Arctic theme page with numerous links to other relevant sites

http://maps.grida.no/arctic/ – Thematic maps of the Arctic region showing populations, ecoregions, and more

http://www.thearctic.is/ – A Web resource on human environment relationships in the Arctic

http://www.dfo-mpo.gc.ca/regions/central/index-eng.htm — Web site produced by Fisheries and Oceans Canada on the Arctic.

Next Generation Science Standards

The primary purpose of this lesson is to assist educators with incorporating information about Arctic microbes and the Mapping the Uncharted Diversity of Arctic Marine Microbes expedition into their instructional program. While they are not intended to target specific Next Generation Science Standards, activities in this lesson may be used to address specific NGSS elements as described below.

HS-LS2 Matter and Energy in Organisms and Ecosystems

Performance Expectation

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

[Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

Science and Engineering Practices

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena or design solutions to support claims.

Disciplinary Core Ideas

- *LS2.B: Cycles of Matter and Energy Transfer in Ecosystems*
  - Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

Crosscutting Concepts

Energy and Matter

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

Common Core State Standards Connections:

Mathematics –

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 1.
Earth has one big ocean with many features.

Fundamental Concept h. Although the ocean is large, it is finite, and resources are limited.

Essential Principle 3.
The ocean is a major influence on weather and climate.

Fundamental Concept g. Changes in the ocean-atmosphere system can result in changes to the climate that in turn, cause further changes to the ocean and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences.

Essential Principle 5.
The ocean supports a great diversity of life and ecosystems.

Fundamental Concept b. Most of the organisms and biomass in the ocean are microbes, which are the basis of all ocean food webs. Microbes are the most important primary producers in the ocean. They have extremely fast growth rates and life cycles, and produce a huge amount of the carbon and oxygen on Earth.

Fundamental Concept d. Ocean biology provides many unique examples of life cycles, adaptations, and important relationships among organisms (symbiosis, predator-prey dynamics, and energy transfer) that do not occur on land.

Essential Principle 6.
The ocean and humans are inextricably interconnected.

Fundamental Concept e. Changes in ocean temperature and pH due to human activities can affect the survival of some organisms and impact biological diversity (coral bleaching due to increased temperature and inhibition of shell formation due to ocean acidification).

Essential Principle 7.
The ocean is largely unexplored.

*Fundamental Concept a.*The ocean is the largest unexplored place on Earth—less than 5% of it has been explored. The next generation of explorers and researchers will find great opportunities for discovery, innovation, and investigation.

Fundamental Concept b. Understanding the ocean is more than a matter of curiosity. Exploration, experimentation, and discovery are required to better understand ocean systems and processes. Our very survival hinges upon it.

Fundamental Concept c. Over the last 50 years, use of ocean resources has increased significantly; the future sustainability of ocean resources depends on our understanding of those resources and their potential.

Fundamental Concept d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

Fundamental Concept f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, physicists, animators, and illustrators. And these interactions foster new ideas and new perspectives for inquiries.

Send Us Your Feedback

In addition to consultation with expedition scientists, the development of lesson plans and other education products is guided by comments and suggestions from educators and others who use these materials. Please send questions and comments about these materials to: *oceanexeducation@noaa.gov*.

For More Information

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Credit

Table 1
Observations on Arctic Gelatinous Zooplankton

		Number of Individuals Observed					
Depth (M)	**Temp. (°C)**	Hydromedusae	Scyphozoans	Siphonophores	Ctenophores	Chaetognaths	Larvaceans
25	-0.9		12		120		
50	-0.2		22	4		4	3
100	-1.2						
150	-1.5					4	
200	-1.4					7	
250	-1.0			6			5
500	0.5	47		2			
750	0.2	15		13	3	15	11
1000	0.0	16					
1250	-0.3	49		16	5		6
1500	-0.4	4					
1750	-0.5						
2000	-0.4						
2250	-0.3						11
2500	-0.3						18

Analysis Guide for Observations on Arctic Gelatinous Zooplankton

1. With the exception of larvacea, all other groups of gelatinous zooplankton appear to be confined to one or two depth ranges. What factors might limit the depth range of these groups? Note that most of groups contain more than one species, so the range for a single species may be less than the range for the entire group.

2. What is different about larvacea that might account for their appearing over a wide depth range?

3. Compare and contrast the feedings strategies of cnidarians (hydromedusae, scyphozoans, siphonophores), ctenophores, chaetognaths, and larvaceans.

4. Ratios of stable nitrogen isotopes in an animal's tissues can be used to determine the trophic level at which the animal is feeding. If nitrogen isotope data were available for the groups listed in the table, would you expect the ratios to be the same or different?

5. Core samples from deep bottom habitats contained specimens that were identified as scyphozoans. Since the class Scyphozoa consists of the "true jellyfish," why were these specimens found in samples of benthic habitats?

6. Graph water temperature data with temperature on the y-axis. Use a logrithmic scale for the y-axis. At what depth does the minimum temperature occur? What is the depth at which the maximum temperature occurs? What causes this temperature distribution (Hint: Look at a map of the Arctic region and neighboring water masses)? How might this affect the distribution of gelatinous zooplankton?

7. Compared to other pelagic organisms, relatively little research has been done on gelatinous zooplankton, and until recently these organisms were considered to be unimportant to marine food webs. Why?