OCEAN NETWORKS CANADA

Ocean Sense
Program

Lesson 3

Module:

Arctic Ocean Biodiversity

Time:

60 minutes

Learning pillars:

- Indigenous knowledge
- Ocean science
- Data exploration

Grade & curriculum connection:

- **BC Science 7**
  "Evolution by natural selection provides an explanation for the diversity and survival of living things."

Created with knowledge from:

Rebecca Ukullaq, Salomie Qitsoalik, Jimmy and David Qirqqut, Danny Aaluk, and Zoe Ohokannoak

A UNIVERSITY OF VICTORIA INITIATIVE

Exploring Arctic Ecology with Transects and Quadrats

Observe, measure, and record Arctic ocean species in Cambridge Bay, Nunavut using transects and quadrats. Model an ecological study using authentic data.

Transects and quadrats are scientific tools used to help scientists and researchers document and describe the species in a study area. Used together or independently, these tools help researchers extrapolate the species diversity and distribution within a large environment. **Baseline** ecological data can be gathered using these tools; when study sites are surveyed over multiple time periods, the data can be compared and changes can be evaluated.

Learning objectives

- Observe, measure, and record data using equipment with accuracy and precision.

Materials

- Computer with internet connection
- Projector and screen
- Slide deck: **Arctic Ocean Biodiversity (bit.ly/SlidesAOB)**
- Activity: *Transects and Quadrats* and all materials listed therein

Teacher preparation

- Preload the slide deck: **Arctic Ocean Biodiversity (bit.ly/SlidesAOB)**
- Prepare materials from activity: *Transects and Quadrats*

Classroom instructions

Hook

1. Share slide 27 and ask the students to count all the crabs in the image in one minute.
2. Discuss the experience with the following questions:
    a. Do you think your count of crabs is accurate?
    b. What makes this task difficult?
    c. What could make this task easier?
    d. How could your count be more accurate?
    e. How would the count be impacted if the crabs were moving?

Step-by-step process

3. Discuss that scientists have developed two tools to collect data about an ecosystem: quadrats and transects. Emphasize that it is not the only way to know an ecosystem.
4. Share slides 28-31 to define transects and quadrats.
5. Share slides 32-35 to provide real world applications of ecological data gathering in Cambridge Bay. A point to emphasize is that the Inuit have always had in-depth knowledge of local ecology.
6. Complete the activity *Transects and Quadrats*.
7. Share slide 37 to review the importance of random placement.
    a. *Potential answers: Random placement of transects and quadrats allows more accurate count of species within a study site. If more challenging locations, like the rock pictured on the slide, are not observed, certain species might not be represented or underrepresented.*
    b. *Potential answers: Random placement of transects and quadrats means that some locations might be difficult to access.*
8. Share slide 38 to rewatch the highlight video from Ocean Networks Canada's underwater observatory in Cambridge Bay. Invite the students to identify species from the activity *Transects and Quadrats* and support them noticing species abundance and richness.
    a. Two of the most abundant species are tube-dwelling anemones and tube-building worms which look like small tube-like structures sticking up from the seafloor.
    b. The highlight video demonstrates species richness because it features the unique species that have swum by the camera.

Modifications and adaptations

- Mobility limitations can be addressed with transects hung up like a garland for students to view more easily.
- Print the image on slide 27 in order for the students to practice a transect and quadrat on paper before trying the activity Transects and Quadrats.

Final remarks to the educator

Transects and quadrats are extremely useful tools for basic ecological study. There are many variations of how to conduct studies using these tools. For example, transect and quadrat data can be multiplied to make estimates of species coverage (density) across a study area. In scientific studies, species diversity is a calculation of the total number of organisms of all species divided by the total number of organisms of each species.

The activity is a simplified model of how to use transects and quadrats so the benefits and challenges associated with these tools are not completely exemplified. The model also doesn't touch on species evenness, which is a measure of how evenly distributed a species is within the study site. Finally, it is important to recognize the experiences, relationships, and observations of Inuit and Indigenous knowledge holders, many of whom have lived on the land from time immemorial. Acknowledging multiple ways of knowing provides a holistic way to understand an ecosystem.

Assessment

- Observe students during the activity *Transects and Quadrats* and assess their ability to observe, measure, and record data using equipment with accuracy and precision.

- Pose questions 4, 5, 8, 9, 10, or 11 from the worksheet *Transects and Quadrats*.

Extensions

- Add additional survey data from Heywood et al. (2016) in the activity *Transects and Quadrats*.
- Launch an inquiry into the importance of collecting baseline data.

Glossary

Baseline data: The first data in a research site that provides reference points against which to compare later data; change and impact can only be measured if baseline data is gathered.

Transect: An ecological tool to observe and catalogue species abundance, richness, biodiversity, and distribution across a study site; a survey line, often rope, along which systematic observations can be collected. Can be used in conjunction with quadrats.

Quadrat: An ecological tool to observe and catalogue species abundance, richness, biodiversity, and distribution in a study site; a defined space of a specific size within which systematic observations can be collected. Can be used in conjunction with transects.

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Activity 2

Module:

Arctic Ocean Biodiversity

Lesson:

Exploring Arctic Ecology with Transects and Quadrats

Learning pillars:

- Ocean science
- Data exploration

Grade & curriculum connection:

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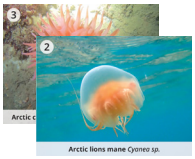
Transects and Quadrats

Perform a transect and quadrat survey to demonstrate how these ecological tools catalog and document species in a given area. The locations and species used in this activity are authentic data from Cambridge Bay.

Materials



- 4 x 5m pieces of rope
- 2 x coloured *Transect and Quadrat cards*
- 4 hula hoops
- Field or open space
- 1 per student worksheet: *Transects and Quadrats*
- 1 per student pencil or pen

Teacher preparation

- Print two copies of the *Transect and Quadrat cards*
- Cut out the *Transect and Quadrat cards*
- Copy the worksheet *Transects and Quadrats* for each group of students
- Determine the area of play and out of bounds in the large play space such as a field or gym
- Set up the transects (see Figure 1 on following page):
  - Use the pieces of rope to set up four transects running parallel to each other at different depths.
  - At the end of each transect place the depth marker accordingly.
  - Place each of the four sets of species cards along the designated transect line. The cards within one transect can be placed randomly so the species are touching the rope.
- Divide the students into small groups of 3-4

Figure 1

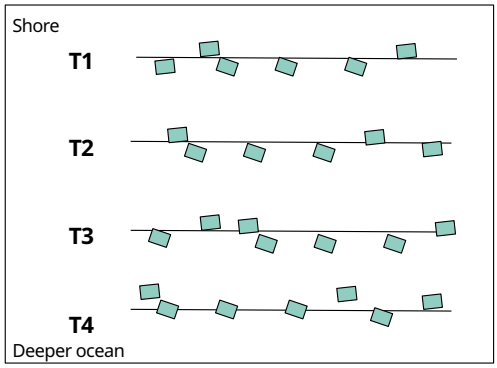


Figure 2

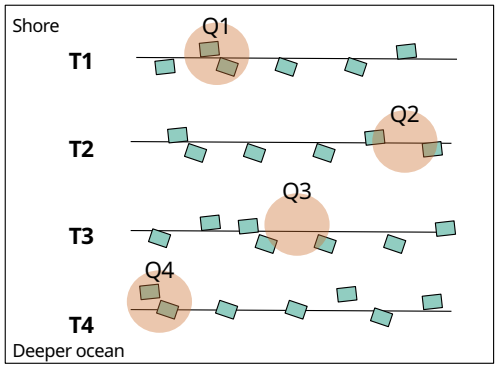


Figure 1: Set up the transects (T) with the *Transect and Quadrat cards* (▭). Note: not all cards provided in the materials are shown in this figure.

Figure 2: Set up the quadrats (Q) along the transects (T). Note: this is just an example and that the quadrats should be spread out randomly.

Procedure

1. Show the playing area as having different depths in the ocean, confirming that the students see where it is close to shore and where there is deeper water. You may wish to show slide 36 to connect the activity to real data collection sites in Cambridge Bay.
2. Explain that each group will explore the entire depth of the area of play by having one team member complete one transect. In other words, there will be multiple students from different groups counting species along each transect.
3. Explain that because this is a model, they can assume all species fall within the distance from the transect line to be included in the count; this would not be the case in nature.
4. Remind the students that the species cards should not be moved around; they are recording the species in situ.

Round 1

5. Allow the students to count the species along each transect, using their worksheet for data recording.
6. Ask the small groups to compare the results of the species found along each transect.
    a. Encourage them to notice that species abundance is not represented in this activity because there are only two individuals of each species present.
7. Complete questions #1-5 in the worksheet. If you make a copy of the slide deck, you can edit slides 40 & 41 to record the data from the whole class.

Round 2

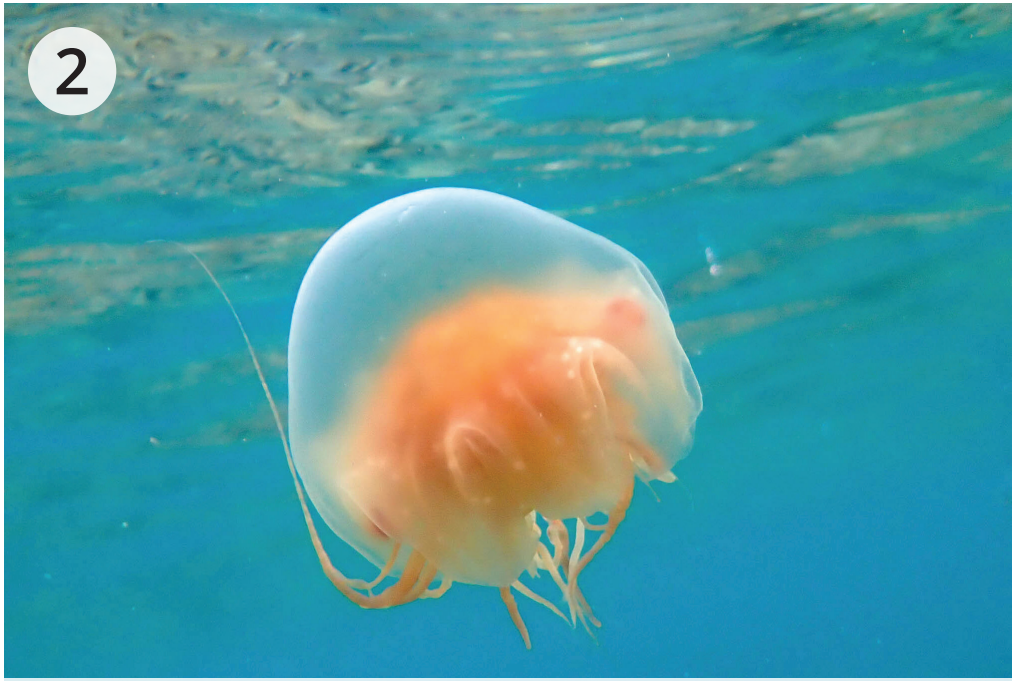
8. Place the hula hoop quadrats at random locations along the transects (see Figure 2).
9. Allow one student from each group to count the species within each quadrat along the transect that they originally counted, using their worksheet for data recording.
10. Ask the small groups to compare the results of the species found in each quadrat.
11. Complete questions #6-11 in the worksheet. If you make a copy of the slide deck, you can edit slides 42 & 43 to record the data from the whole class.

Conclusion

Both transects and quadrats are useful tools in ecological studies because they do not require specialized equipment so it is inexpensive and easy for researchers to use. These tools assess distribution and abundance of species in a given area. Transects allows researchers to quickly gather data about species richness and changes between different locations within the study site. Quadrats are useful for seeing species abundance and distribution in a study site, although this model did not fully highlight this value.

It is important to note that both transects and quadrats have some limitations. Both tools are susceptible to researcher bias if they are not placed randomly throughout the study site. Species may be missed if they are clumped in certain areas within a study site, and fast moving or rare species may not be accounted for. Nevertheless, transects and quadrats are useful ecological tools that are used by researchers and scientists.

Arctic crimson anemone *Cribrinopsis similis*

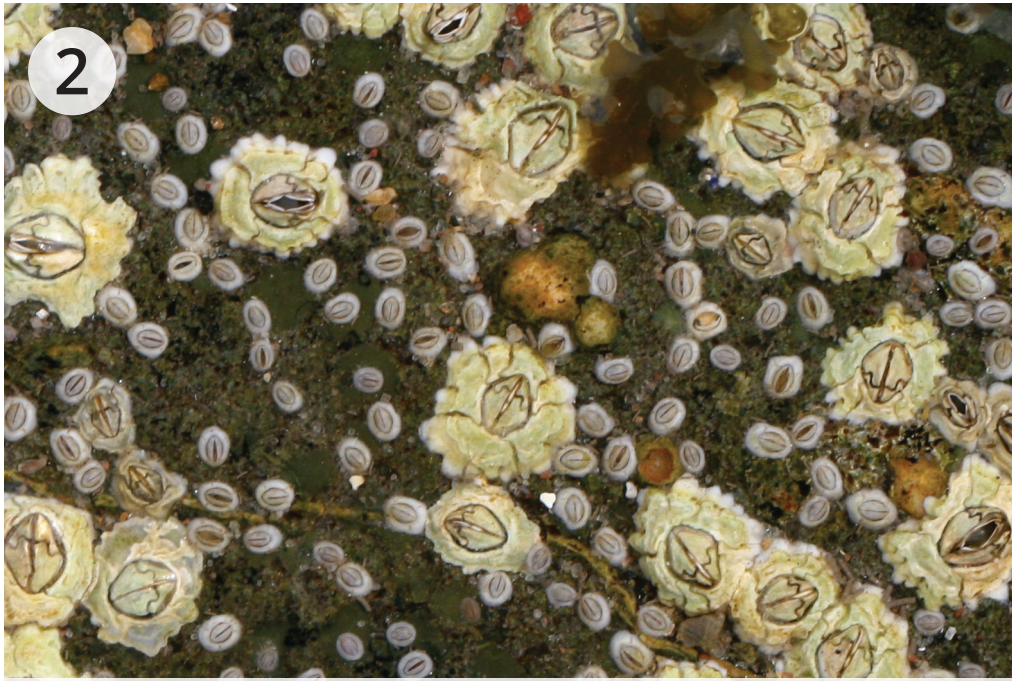


Arctic lions mane *Cyanea sp.*

Arctic lyre crab *Hyas coarctatus*

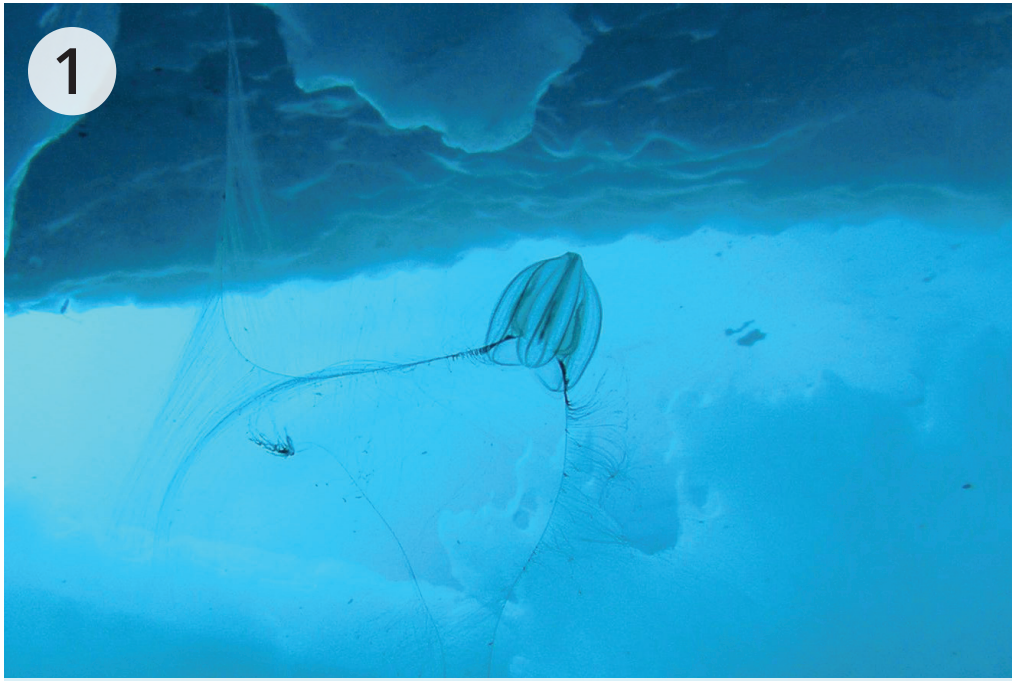
Arctic saxicave *Hiatella arctica*

Arctic shanny *Stichaeus punctatus*



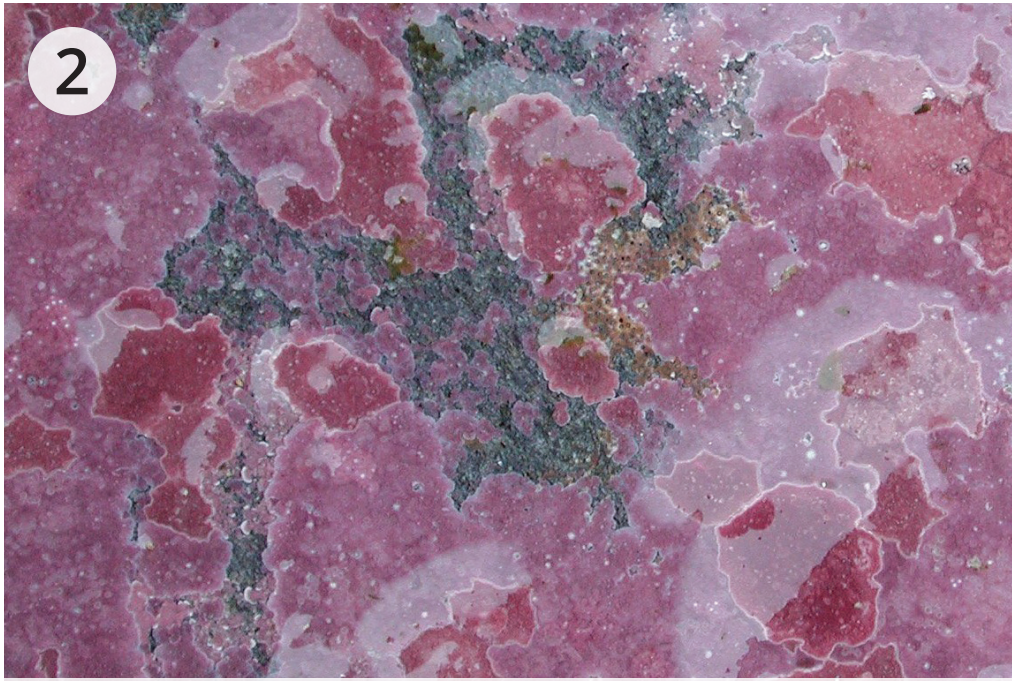
Barnacle *Balanus sp.*

Burrowing anemone *Halcampa arctica*



Comb jelly *Mertensia ovum*

Cone worm undetermined *Pectinaria* worm

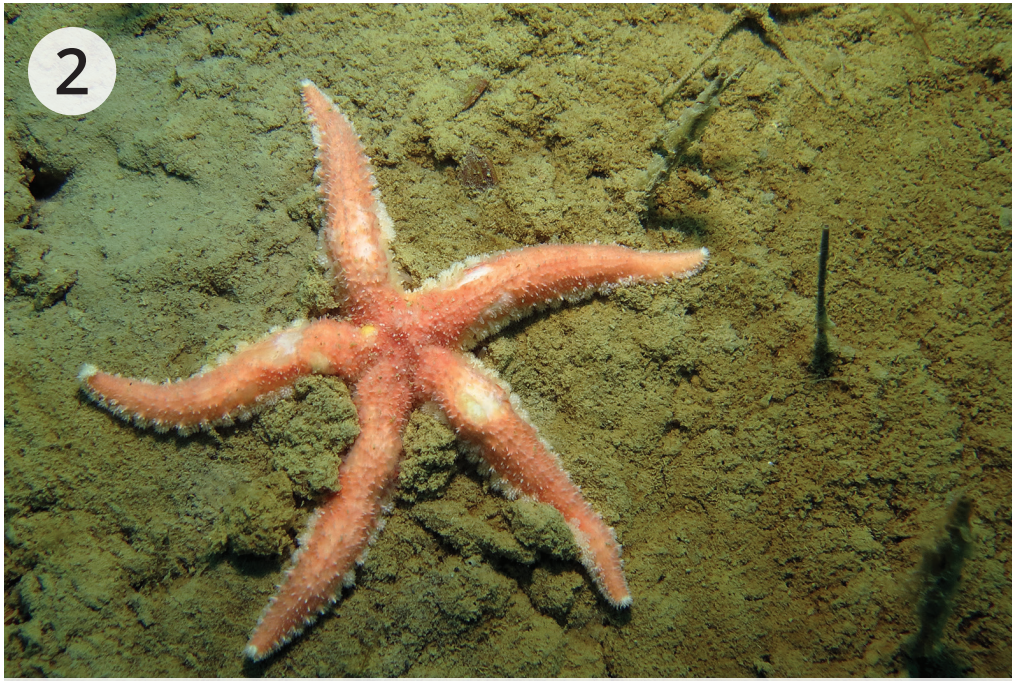


Coralline algae *Corallina sp.*

Discordant mussel *Musculus discor*

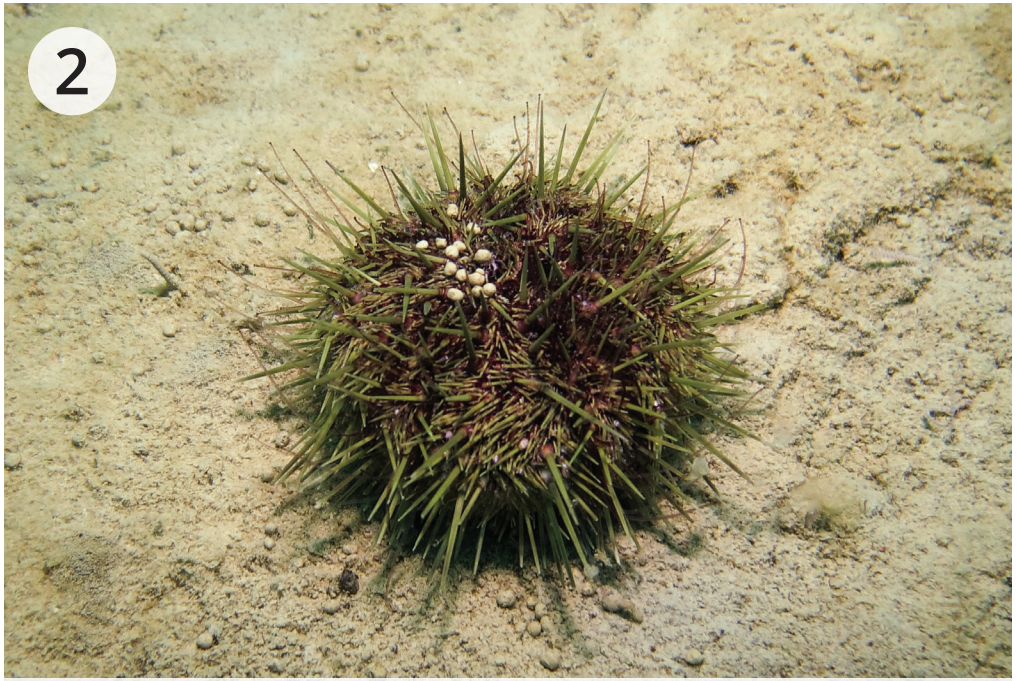
Double bubble jelly *Halitholus cirratus*

Four-horned sculpin *Myoxocephalus quadricornis*



Frilled sea star possibly *Urasterias lincki*

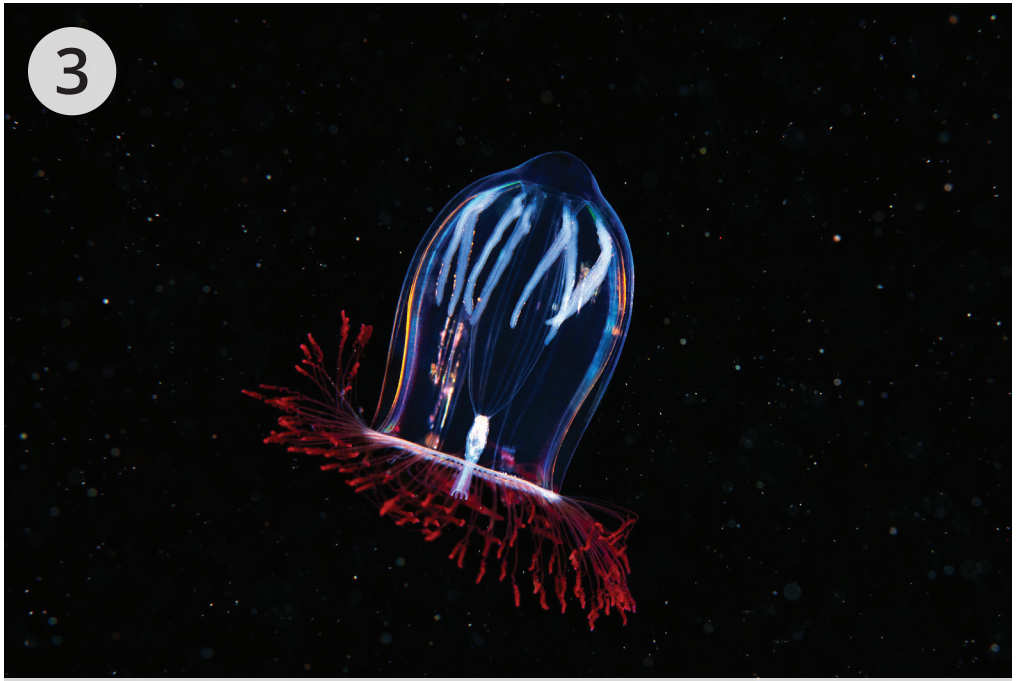
Giant black sea cucumber *Cucumaria frondosa*



Green sea urchin *Strongylocentrotus droebachiensis*

Greenland cod *Gadus ogac*

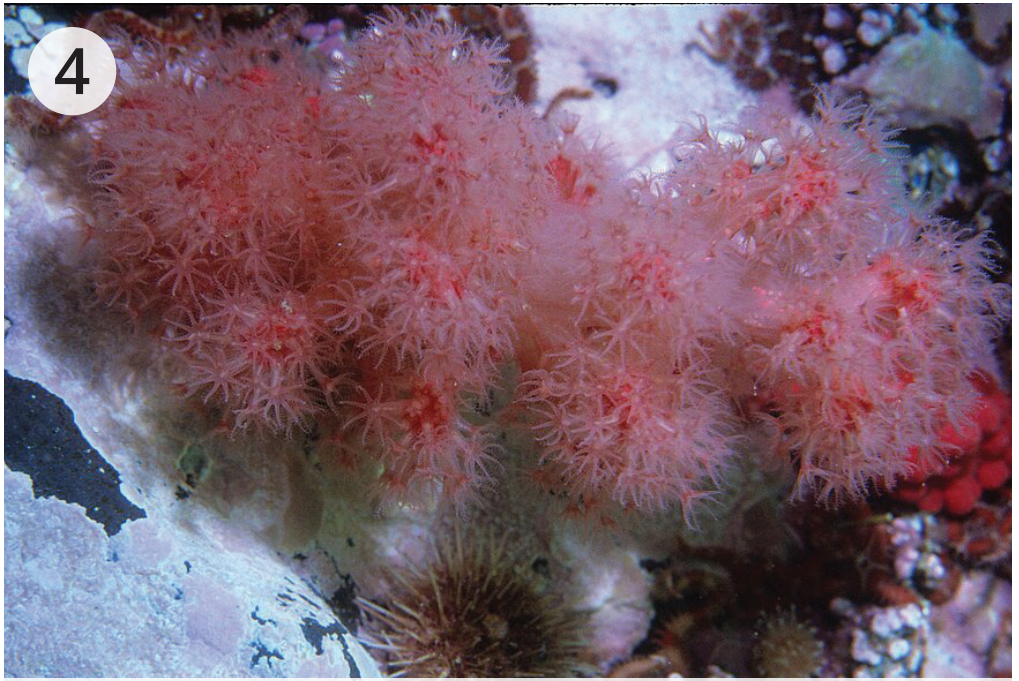
Hedgehog amphipod *Paramphithoe hystrix*



Hydromedusa *Aglantha digitale*

Iceland cockle *Clinocardium ciliatum*

Peachy burrowing sea cucumber *Psolus phantapus*



Red or white soft coral *Gersemia rubiformis*

Ribbed sculpin *Triglops pingelii*

Ridged Buccinum snail poss. *Buccinum scalariforme*

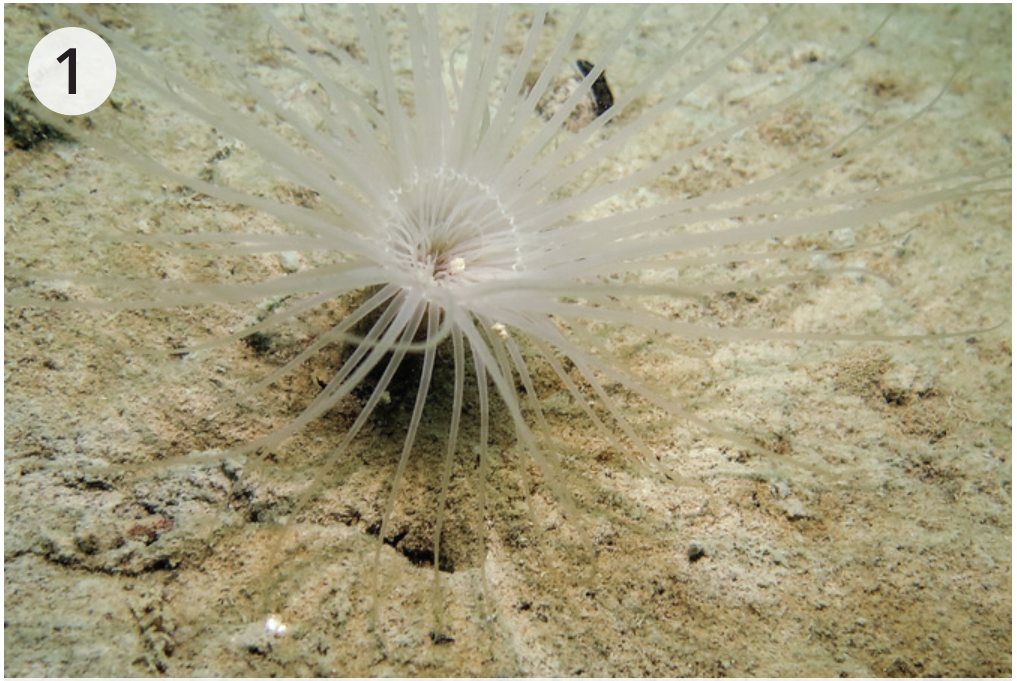
Rockweed *Fucus sp.*

Rose seaweed poss. *Palmaria palmata*

Rose star *Crossaster papposus*

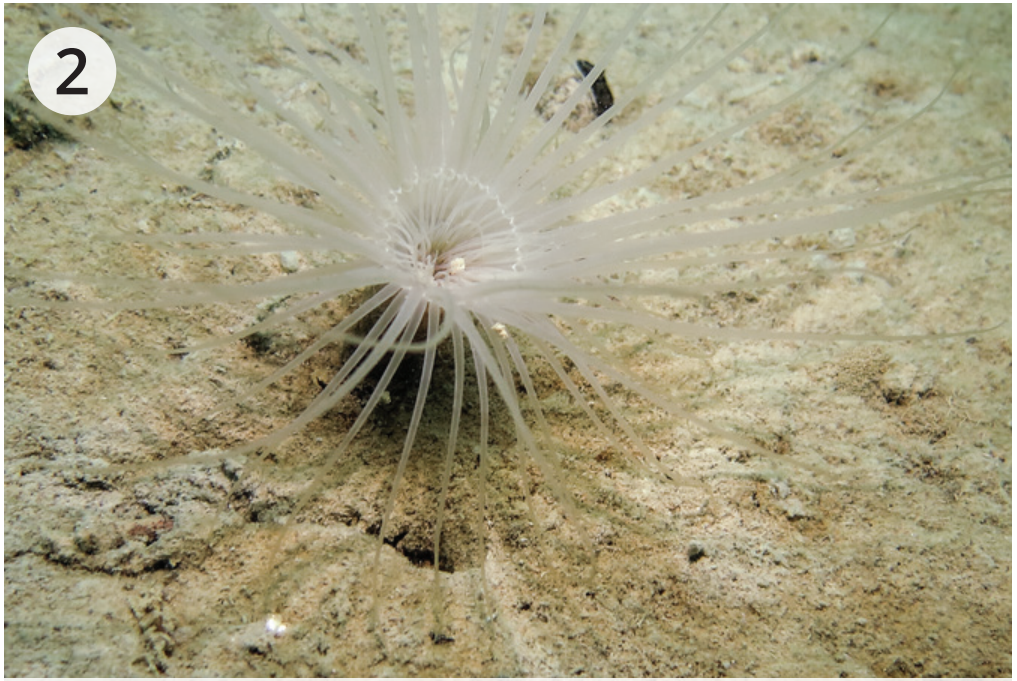
Truncated mya *Mya truncata*

Sugar kelp *Saccharina latissima*



Tube-dwelling anemone poss. *Pachycerianthus borealis*

Sugar kelp *Saccharina latissima*



Tube-dwelling anemone poss. *Pachycerianthus borealis*

Arctic saxicave *Hiatella arctica*

Cone worm undetermined *Pectinaria* worm

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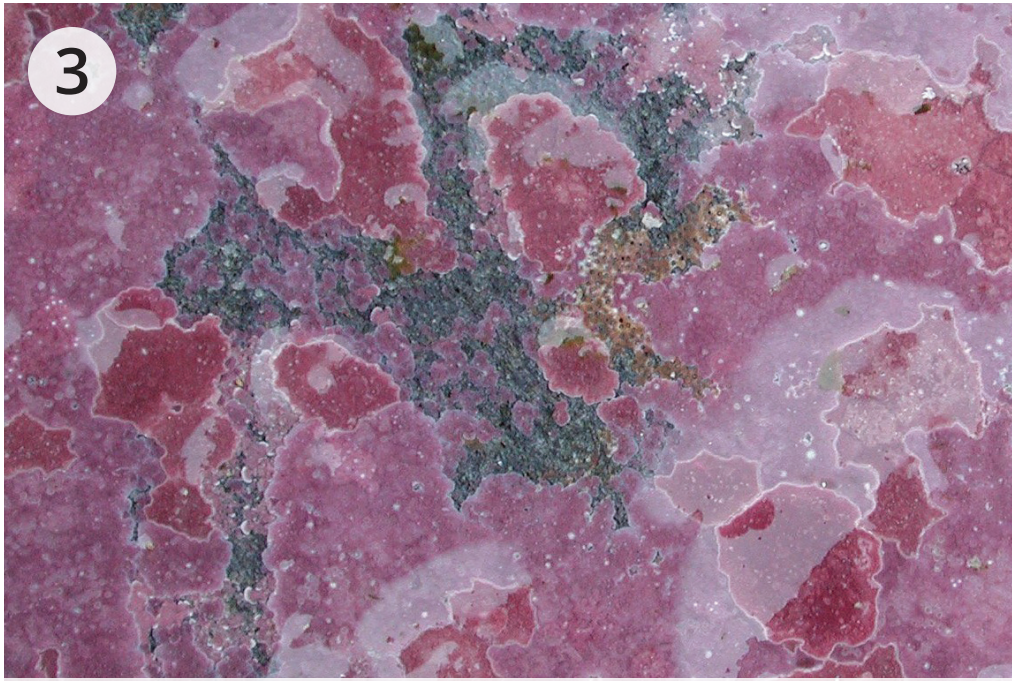
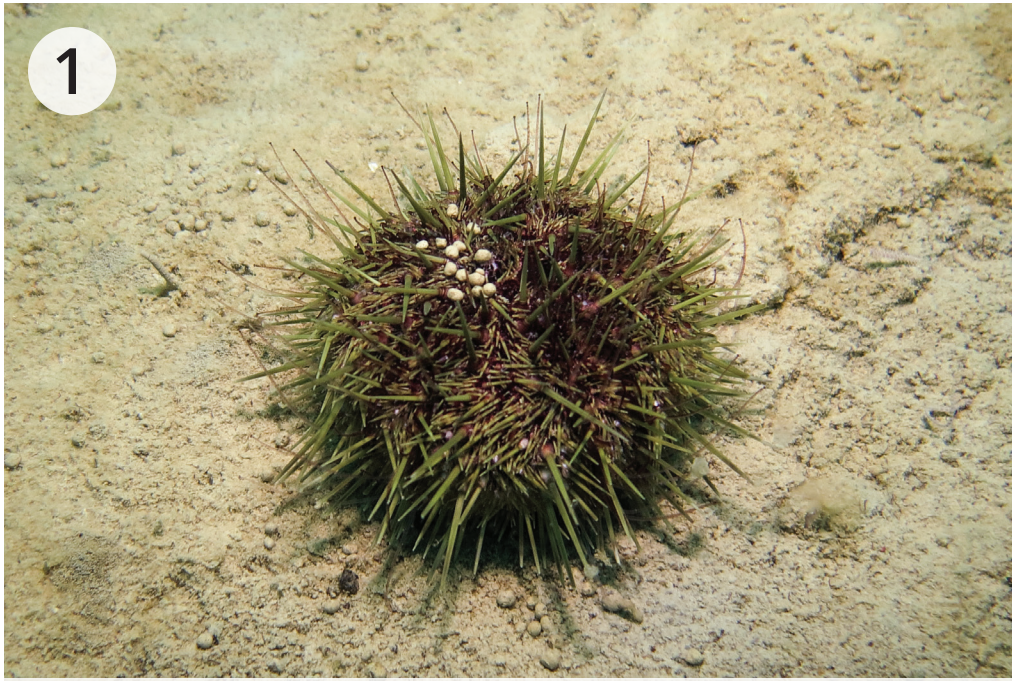
Arctic saxicave *Hiatella arctica*

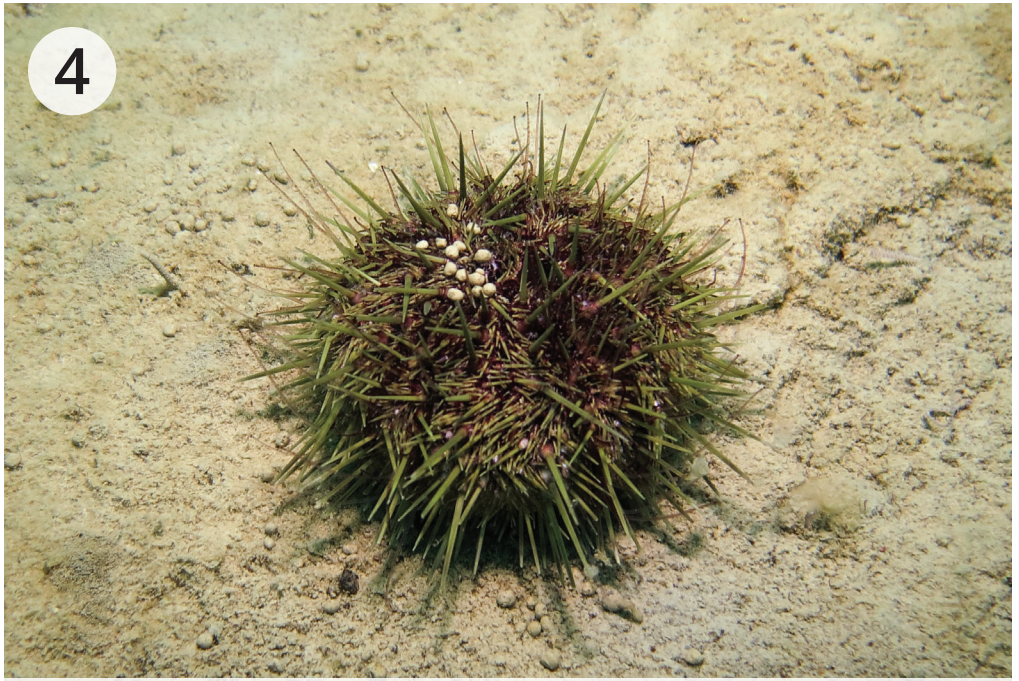


Coralline algae *Corallina sp.*



Green sea urchin *Strongylocentrotus droebachiensis*

Cone worm undetermined *Pectinaria* worm



Green sea urchin *Strongylocentrotus droebachiensis*

Name: _____

Transects and Quadrats

Data Recording: Round 1

Transect: _____

Depth: _____

Location: _____

SPECIES	SCIENTIFIC NAME	PRESENT
Arctic crimson anemone	*Cribrinopsis similis*	
Arctic lions mane	*Cyanea sp.*	
Arctic lyre crab	*Hyas coarctatus*	
Arctic saxicave	*Hiatella arctica*	
Arctic shanny	*Stichaeus punctatus*	
barnacle	*Balanus sp.*	
burrowing anemone	*Halcampa arctica*	
comb jelly	*Mertensia ovum*	
cone worm	undetermined *Pectinaria* worm	
coralline algae	*Corallina sp.*	
discordant mussel	*Musculus discor*	
double bubble jelly	*Halitholus cirratus*	
four-horned sculpin	*Myoxocephalus quadricornis*	
frilled sea star	possibly *Urasterias lincki*	
giant black sea cucumber	*Cucumaria frondosa*	
green sea urchin	*Strongylocentrotus droebachiensis*	
Greenland cod	*Gadus ogac*	
hedgehog amphipod	*Paramphithoe hystrix*	
hydromedusa	*Aglantha digitale*	
Iceland cockle	*Clinocardium ciliatum*	
peachy burrowing sea cucumber	*Psolus phantapus*	
red or white soft coral	*Gersemia rubiformis*	
ribbed sculpin	*Triglops pingelii*	
ridged Buccinum snail	possibly *Buccinum scalariforme*	
rockweed	*Fucus sp.*	
rose seaweed	possibly *Palmaria palmata*	
rose star	*Crossaster papposus*	
sugar kelp	*Saccharina latissima*	
truncated mya	*Mya truncata*	
tube-dwelling anemone	possibly *Pachycerianthus borealis*	

Data Recording: Round 2

Quadrat: _____

Depth: _____

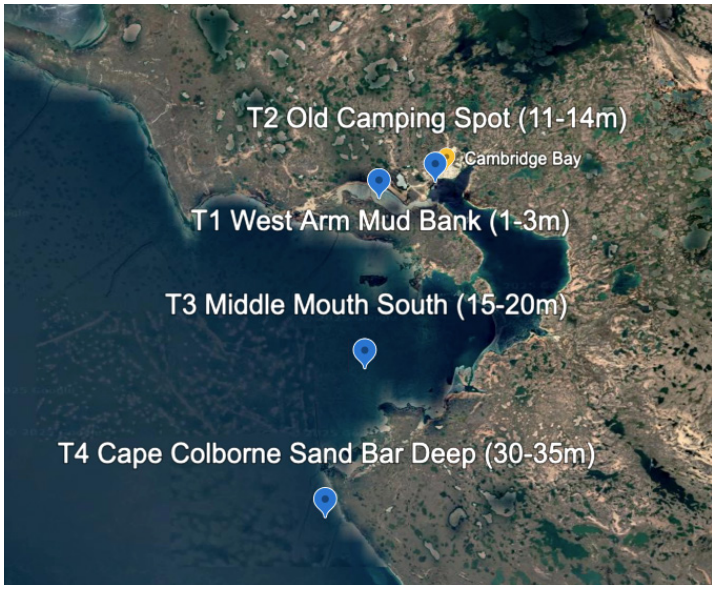
Location: _____

SPECIES	SCIENTIFIC NAME	PRESENT
Arctic crimson anemone	*Cribrinopsis similis*	
Arctic lions mane	*Cyanea sp.*	
Arctic lyre crab	*Hyas coarctatus*	
Arctic saxicave	*Hiatella arctica*	
Arctic shanny	*Stichaeus punctatus*	
barnacle	*Balanus sp.*	
burrowing anemone	*Halcampa arctica*	
comb jelly	*Mertensia ovum*	
cone worm	undetermined *Pectinaria* worm	
coralline algae	*Corallina sp.*	
discordant mussel	*Musculus discor*	
double bubble jelly	*Halitholus cirratus*	
four-horned sculpin	*Myoxocephalus quadricornis*	
frilled sea star	possibly *Urasterias lincki*	
giant black sea cucumber	*Cucumaria frondosa*	
green sea urchin	*Strongylocentrotus droebachiensis*	
Greenland cod	*Gadus ogac*	
hedgehog amphipod	*Paramphithoe hystrix*	
hydromedusa	*Aglantha digitale*	
Iceland cockle	*Clinocardium ciliatum*	
peachy burrowing sea cucumber	*Psolus phantapus*	
red or white soft coral	*Gersemia rubiformis*	
ribbed sculpin	*Triglops pingelii*	
ridged Buccinum snail	possibly *Buccinum scalariforme*	
rockweed	*Fucus sp.*	
rose seaweed	possibly *Palmaria palmata*	
rose star	*Crossaster papposus*	
sugar kelp	*Saccharina latissima*	
truncated mya	*Mya truncata*	
tube-dwelling anemone	possibly *Pachycerianthus borealis*	

Round 1

Compare the transect data from all group members to answer the following questions:

1. Species richness varies between transects. Provide a possible explanation.



2. Were there any species found in all four transects? If yes, please list them and provide a possible explanation.

3. Each transect line spans a depth range (i.e. Old Camping Spot ranges in depth from 11-14m). Why might this be?

4. What advantages does a transect offer researchers?

5. What challenges might researchers face in using a quadrat?

Round 2

Compare the quadrat data from all group members to answer the following questions:

6. Species richness varies between transects. Provide a possible explanation.

7. Were there any species found in a transect but were not in a quadrat?
   If yes, please list them and provide a possible explanation.

8. What advantages does a quadrat offer researchers?

9. What challenges might researchers face in using a quadrat?

10. What is the benefit of using a transect and a quadrat together?

11. How would local knowledge inform the use of these tools?

Answer Key

Round 1

1. Each transect is at a slightly different depth range which may correspond to different habitats. Species are adapted to specific habitats so that is why they are found in particular locations.
2. The cone worm was the only species found in all four transects. This might be because it is well adapted to all the different depths of habitats. Other species were also found in multiple transects: tube-dwelling anemone T1 and T2; Arctic saxicave T1, T3, and T4; green sea urchin T1, T2, T4; sugar kelp T2 and T3; coralline algae T2 and T3.
3. The seafloor is not a consistent depth so the transect follows the contours of the seafloor.
4. A transect does not require specialized equipment so it is inexpensive and easy for researchers to set up. The transect allows researchers to quickly gather data about the species richness in a study site and how the species present changes between different locations within the study site.
5. If species are clumped in certain areas within a study site, they might be missed. Transects should be placed at random in a study site but it may be easier for a researcher to place it in an in area that is easy to access.

Round 2

6. Answers will vary depending on where the quadrats are placed.
7. Answers will vary depending on where the quadrats are placed.
8. A quadrat does not require specialized equipment so it is inexpensive and easy for researchers to set up. It is useful for seeing how many individuals of which species (i.e. species abundance) are present in a study site. It allows researchers to see where species are located within the study site.
9. A quadrat would not work well for fast moving or rare species. Quadrats should be placed at random in a study site but it may be easier for a researcher to place them in areas that are easy to access.
10. Used together, transects and quadrats allow researchers to make a more accurate estimate of the species abundance and richness in a study site.
11. Local community members may know of specific locations within a study site that are rich with particular or rare species. Community members would also know the human history of certain sites which might have a connection to the species present. For example, transect 2 is called “The Old Camping Spot” so perhaps there is something unique about why this site used to be a camping location.