ocean explorer
oceanexplorer.noaa.gov

Arctic Ocean Exploration

Would You Like a Sample?

Focus
Sampling strategies for biological communities

Grade Level
7-8

Focus Question
How well do biological samples represent the actual biological communities from which they are taken?

Learning Objectives
Students will be able to identify the three realms of the Arctic Ocean, and describe the relationships between these realms.

Students will be able to discuss the advantages and limitations of sampling techniques to study biological communities.

Additional Information for Teachers of Deaf Students
In addition to the words listed as key words, the following words should be part of the vocabulary list.
Benthic
Pelagic
Zooplankton
Phytoplankton
Sympagic
Primary productivity
Continental shelf
Diatoms
Algae
Photosynthesis
Chemosynthesis
Primary production
Submarine
Brine channels

There are no formal signs in American Sign Language for any of the key words and many are difficult to lipread. Having the vocabulary list on the board as a reference during the lesson will be extremely helpful. Additional information regarding ROV,s and ABE can be added and will help students understand the potential limits and advantages of sampling.

Materials
- ❒ Paper grid cells; ideally, make one set for each student group (copy and cut from master included in lesson plan)
- ❒ Blank "Sampling Plan Sheets," one for each student group (copy from master included in lesson plan)
- ❒ Blank "Sampling Plan Data Sheets," one for each student group (copy from master included in lesson plan)
- ❒ "Complete List of All Organisms in the Model Community;" copy this onto an overhead transparency if desired to use during discussion of results
- ❒ Table of random numbers, or telephone directory

Audio/Visual Materials
None, unless an overhead projector is desired to facilitate discussions

Teaching Time
One or two 45-minute class periods

Seating Arrangement

Groups of four or five students

Maximum Number of Students

30

Key Words

Pelagic
Benthic
Sympagic
Transect
Quadrat
Grid

Background Information

The Arctic Ocean is the smallest of the world's four ocean basins with a total area of about 5.4 million square miles or 14 million square kilometers (roughly 1.5 times the size of the United States), and is bordered by Greenland, Canada, Alaska, Norway, and Russia. The Arctic Ocean has the widest continental shelf of any ocean, extending 750 mi (1,210 km) from the coast of Siberia, but also has areas that are quite deep (the average depth is 12,000 ft (3,658 m) and the maximum depth is 17,850 ft (5,441 m)). The Chukchi Sea provides a connection with the Pacific Ocean via the Bering Strait, but this connection is very narrow and shallow, so most water exchange is with the Atlantic Ocean via the Greenland Sea.

The floor of the Arctic Ocean is divided by three submarine ridges (Alpha Ridge, Lomonosov Ridge, and the Arctic Mid-Oceanic Ridge), one of which (the Lomonosov Ridge) creates a relatively isolated area known as the Canadian Basin. This area is particularly interesting to scientists because its isolation could mean that it contains unique life forms that are found nowhere else on Earth. But the Arctic Ocean is not easily explored; it is almost entirely covered with ice for eight months of the year, a drifting polar ice pack covers the central and western portions year-round, and sea temperature seldom rises above 0°C. Although the Arctic is still the world's least explored ocean, new expeditions are about to give us much greater knowledge of the mysteries of this polar frontier.

At this point, we know that there are at least three distinct biological communities in the Arctic Ocean. The Sea-Ice Realm includes plants and animals that live on, in, and just under the ice that floats on the Arctic Ocean's surface. Because only 50% of this ice melts in the summer, ice flows can exist for many years and can reach a thickness of more than six ft. (2 m). Sea ice is not usually solid like an ice cube, but 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. This community of organisms is called sympagic, which means "ice-associated." Partial melting of sea ice during the summer months produces ponds on the ice surface that contain their own communities of organisms. Melting ice also releases organisms and nutrients that interact with the ocean water below the ice.

The Pelagic Realm includes organisms that live in the water column between the ocean surface and the bottom. Melting sea ice allows more light to enter the sea, and algae grow rapidly since the sun shines for 24 hours a day during the summer. These algae provide energy for a variety of floating animals (zooplankton) that include crustaceans and jellyfishes. Zooplankton, in turn, are the energy source for larger pelagic animals including fishes, squids, seals, and whales.

When pelagic organisms die, they settle to the ocean bottom as detritus, and become the energy source for inhabitants of the Benthic Realm. Sponges, bivalves, crustaceans, polychaete worms, sea anemones, bryozoans, tunicates, and ascidians are common members of Arctic benthic communities. These animals provide energy for bottom-feed-

ing fishes, whales, and seals.

Most of our knowledge about biological communities in the Arctic Ocean comes from studies on portions of the Ocean near the continental shelves. Very little research has been done on the sea ice, pelagic, and benthic realms in the deepest parts of the Arctic Ocean. These areas are the focus of the Arctic Ocean Expedition.

One of the classic problems faced by researchers working on biological communities is how best to sample the living organisms that make up these communities. Even if all of the organisms are large enough to see and are out in the open on a flat surface, it is usually impractical to count every single organism present. So researchers have developed various systems for taking samples from a community, and then using these samples to draw conclusions about the community as a whole. There is always a question, though, of how well the samples represent the community. The situation becomes even more complicated when organisms are hidden under rocks or in sediment, or are very small, or very large, or very fast. New technologies, including remotely operated vehicles (ROVs), underwater video recorders, high resolution digital cameras, and side scan sonar are being used by researchers on the Arctic Ocean Expedition to overcome some of the difficulties of sampling biological communities. Still, the researchers know that some organisms will go undetected.

Learning Procedure

In this activity, students will use several common sampling techniques to investigate an "unknown" biological community, and will compare the strengths and weaknesses of these techniques in giving an accurate impression of the community's organisms.

1. Arrange one or more sets of paper grid cells face down on a table (an area of about 30 in. x 30 in. will be needed for each set). Be sure that cells are arranged in grid order, so that the cell labeled "1,1" is in the lower left corner, and the cell labeled "20,20" is in the upper right corner. Ideally, have one set of cells for each student group; this will make the activity go much more quickly!

2. Review Background Information on the Arctic Ocean and its three known biological realms. Emphasize that the Expedition will be investigating many areas that have never been explored before, and that researchers have only a general idea of what they will find. Tell the students that their task is to develop a sampling plan for a benthic community 10,000 feet deep the Arctic Ocean. Side scan sonar indicates that the area is almost completely flat, with no large rocks or other distinct features. Using precision mapping and global positioning equipment, the site has been divided into a grid of 400 squares. The overall plan is to send an ROV to the site to collect samples, but because there are many other areas to investigate, sampling time is limited, and only 25 grid squares can be sampled from this site. The good news is that the ROV is equipped with photographic and video equipment, as well as a variety of manipulator arms and sampling devices, so we have a good chance of detecting the most of the non-microscopic organisms present in the community.

3. Lead a discussion with the students of how they might arrange their sampling program. One of the most commonly used sampling systems is to establish one or more lines (called transects) across the study area, and then take samples at fixed intervals along the transect line. For visual surveys, these samples are often taken within a square area of fixed size (called a quadrat). In the case of our model community, individual quadrats are represented by the individual grid squares.

   As an alternative to the transect technique, students should consider the possibility of collecting samples randomly throughout the community, and discuss the advantages and

disadvantages of each approach. To apply a random sampling system to the model community, each grid square should be assigned a pair of coordinates beginning with 1,1 (for the square in the lower left corner) and ending with 20,20 (for the square in the upper right corner), just as one would describe coordinates on a piece of graph paper. Then grid squares to be sampled would be identified using a table of random numbers taken four at a time (so if the first four numbers in the table were 1,3,0,7 the first square to be sampled would be 13 squares across and seven squares up).

Coordinate pairs greater than 20,20 are skipped, and the process continued until 25 usable coordinate pairs have been selected. If a table of random numbers is not available, use a telephone directory, using the last digit of each number beginning with the first listing in the directory.

Once the students have collected their data, they may be somewhat overwhelmed by three pages of numbers and strange names that they need to process. One of the most important lessons to be learned through this activity is how to manage this sort of data set. The key to good data analysis is to define exactly what information is needed from the data, before the data are collected. Be sure the students understand that for this activity we want to know:

(a) what species groups are present in the model community;
(b) the relative abundance of these groups; and
(c) which species groups tend to occur together (because these associations give clues as to how different species groups may be interacting in the community).

4. Have each student group select a sampling technique, and diagram their sampling plan on a blank "Sampling Plan Sheet." Try to have some groups use a random sampling system, and others use a transect system.

5. Have each group turn over the paper grid cells that correspond to their sampling plan, and record the results on a "Sampling Plan Data Sheet." If more than one group is using a set of cells, have the groups work one at a time (groups using a transect system could begin while groups using a random system are identifying their sample cells with a random numbers table). Be sure all of the cells are face down again before another group begins to collect data.
6. Have each group analyze their data to answer the three questions listed in Step 3. First, make a list of all the species groups found; this answers question (a).

Next, tally the number of quadrats in which each group occurred. Classify each group as "Abundant" if it occurred in more than 50% of the samples, "Common" if it occurred in 20% but less than 50% of the samples, and "Rare" if it occurred in less than 20% of the samples. This answers question (b).

Finally, identify species groups that are commonly found together. One way to do this is to make a matrix, listing all species groups in vertical columns, and all species groups in horizontal rows. In each cell of the matrix, fill in the number of quadrats in which each species group was found with all the other groups. For example:

	Group A	**Group B**	**Group C**	**Group D**	**etc.**
Group A	20	3	18	12	
Group B		15	5	10	
Group C			23	1	
Group D				14	
etc.					

So, species Group A, which was found in 20 quadrats, is strongly associated with Group C, which was found in 23 quadrats, and possibly with Group D which was found in 14 quadrats. Species Group B, which was found in 15 quadrats, was strongly associated with Group D, but not with the other two groups.

This gives an answer to question (c).

7. Have each group present a summary of their data that includes: the total number of species found, the relative abundance of each species, and which species appear together in more than three samples. Record these summaries on a marker board, flip chart, or overhead transparency. Lead a discussion that includes

(a) comparing the results of the different techniques;
(b) speculation about what features of the model community might lead to the results they obtained;
(c) how organisms are actually distributed in nature (more often clumped than randomly distributed); and
(d) how the students' results could be used to design a follow-up sampling program.

8. Compare the students' results with the "Complete List of All Organisms in the Model Community." This sort of list is almost never available in actual

research situations, but should show how difficult it is for a single sampling program to detect all of the species in a community. Be sure the students understand that they were able to sample 1/16th of the entire model community, and that the coverage possible with most sampling programs is much less.

The BRIDGE Connection

www.vims.edu/bridge/polar.html
www.vims.edu/bridge/benthos.html

The "Me" Connection

Have students write a short essay or prepare a brief oral presentation on how knowledge of unexplored biological communities might benefit them personally, and/or why they think this knowledge is (or is not) important. Ask students to share their thoughts with the rest of the class.

Connections to Other Subjects

Mathematics, Earth Science, Physical Science

Evaluation

Individual sampling plans and data summaries prepared by each student group may be collected to assess the thoroughness of their work. Additionally, students may be asked to define key words and/or address discussion points 6a, b, c, and d in writing before participating in a group discussion.

Extensions

1. Have students visit http://oceanexplorer.noaa.gov to keep up to date with the real-time exploration of the deep Arctic Ocean, and to find out what organisms researchers actually find in the three realms.

2. Have students design an investigation to discover lifeforms on one of the moons of Jupiter. Ask them to consider as many different forms as possible, and to discuss how the techniques used by an expedition to discover new lifeforms might be different from techniques used to investigate a known biological community.

3. Visit http://www.ropos.com to find out about the ROV being used on the Arctic Ocean Expedition to explore biological communities.

4. Have students research species groups that are unfamiliar, and present a brief report describing these groups.

Resources

http://oceanexplorer.noaa.gov – Follow the Arctic Ocean Expedition as documentaries and discoveries are posted each day for your classroom use.

http://www.sciencegems.com/earth2.html – Science education resources

http://www-sci.lib.uci.edu/HSG/Ref.html – References on just about everything

National Science Education Standards

Content Standard A: Science As Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard C: Life Science

- Populations and ecosystems

For More Information

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Acknowledgements

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Student Handout

Grid Cells, page 1

Quadrat 1,1 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 2,1** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 3,1** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 4,1** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 1,2 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 2,2** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 3,2** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 4,2** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 1,3 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 2,3** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 3,3** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 4,3** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 1,4 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 2,4** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 3,4** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 4,4** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 1,5 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 2,5** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails Cumaceans	**Quadrat 3,5** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 4,5** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails

Student Handout

Grid Cells, page 2

Quadrat 9,1 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 10,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 11,1** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 12,1** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails
Quadrat 9,2 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 10,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 11,2** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 12,2** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails
Quadrat 9,3 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 10,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 11,3** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 12,3** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails
Quadrat 9,4 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 10,4** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 11,4** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 12,4** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails
Quadrat 9,5 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 10,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails Ectoprocta	**Quadrat 11,5** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 12,5** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails

Student Handout

Quadrat 5,1 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 6,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 7,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 8,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 5,2 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 6,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 7,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 8,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 5,3 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 6,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 7,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 8,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 5,4 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 6,4** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 7,4** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 8,4** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails
Quadrat 5,5 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 6,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 7,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 8,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Tunicates Brittle Stars Sea Anemones Snails

Student Handout

Quadrat 13,1 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 14,1** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 15,1** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 16,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails
Quadrat 13,2 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 14,2** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 15,2** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 16,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails
Quadrat 13,3 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 14,3** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 15,3** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 16,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails
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Quadrat 13,5 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 14,5** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 15,5** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Tunicates Brittle Stars Sea Anemones Snails	**Quadrat 16,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails

Student Handout

Quadrat 17,1 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 18,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 19,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails	**Quadrat 20,1** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails
Quadrat 17,2 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 18,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 19,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails	**Quadrat 20,2** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails
Quadrat 17,3 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 18,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 19,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails	**Quadrat 20,3** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails
Quadrat 17,4 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 18,4** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 19,4** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails	**Quadrat 20,4** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails
Quadrat 17,5 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 18,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails Nemertine Worms	**Quadrat 19,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails	**Quadrat 20,5** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Tunicates Snails

Student Handout

Quadrat 1,6 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 2,6** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 3,6** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 4,6** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods
Quadrat 1,7 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 2,7** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 3,7** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 4,7** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods
Quadrat 1,8 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 2,8** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 3,8** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 4,8** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods
Quadrat 1,9 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 2,9** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 3,9** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 4,9** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods
Quadrat 1,10 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 2,10** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods Cumaceans	**Quadrat 3,10** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 4,10** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods

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Quadrat 5,6 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 6,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 7,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 8,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods
Quadrat 5,7 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 6,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 7,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 8,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods
Quadrat 5,8 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 6,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 7,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 8,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods
Quadrat 5,9 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 6,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 7,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 8,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods
Quadrat 5,10 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Tunicates Brittle Stars Sea Anemones Isopods	**Quadrat 6,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 7,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods	**Quadrat 8,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods

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Quadrat 9,6 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 10,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 11,6** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 12,6** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods
Quadrat 9,7 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 10,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 11,7** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 12,7** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods
Quadrat 9,8 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 10,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 11,8** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 12,8** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods
Quadrat 9,9 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 10,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 11,9** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 12,9** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods
Quadrat 9,10 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 10,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Tunicates Isopods Ectoprocts	**Quadrat 11,10** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 12,10** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods

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Quadrat 13,6 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 14,6** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 15,6** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 16,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 13,7 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 14,7** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 15,7** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 16,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 13,8 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 14,8** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 15,8** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 16,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 13,9 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 14,9** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 15,9** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 16,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 13,10 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 14,10** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 15,10** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Tunicates Isopods	**Quadrat 16,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods

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Quadrat 17,6 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 18,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 19,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods	**Quadrat 20,6** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 17,7 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 18,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 19,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods	**Quadrat 20,7** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 17,8 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 18,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 19,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods	**Quadrat 20,8** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 17,9 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 18,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 19,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods	**Quadrat 20,9** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods
Quadrat 17,10 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 18,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods Nemertine Worms	**Quadrat 19,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods	**Quadrat 20,10** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Tunicates Isopods

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Quadrat 1,11 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,11** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,11** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,11** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,12 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,12** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,12** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,12** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,13 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,13** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,13** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,13** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,14 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,14** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,14** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,14** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,15 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,15** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,15** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,15** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans

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Quadrat 5,11 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 6,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 7,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,12 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 6,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 7,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,13 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 6,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 7,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,14 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 6,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 7,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,15 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 6,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulids	**Quadrat 7,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans

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Quadrat 9,11 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,11** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 12,11** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans
Quadrat 9,12 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,12** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 12,12** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans
Quadrat 9,13 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,13** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 12,13** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans
Quadrat 9,14 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,14** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 12,14** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans
Quadrat 9,15 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,15** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 12,15** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans

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Quadrat 13,11 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 14,11** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 15,11** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 16,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 13,12 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 14,12** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 15,12** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 16,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 13,13 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 14,13** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 15,13** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 16,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 13,14 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 14,14** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 15,14** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 16,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 13,15 **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 14,15** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans Barnacles	**Quadrat 15,15** **Species Groups Found:** Polychaetes Amphipods Sand Dollars Ascidians Bivalves Polyplacophorans	**Quadrat 16,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves

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Quadrat 17,11 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 18,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 19,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 20,11** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 17,12 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 18,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 19,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 20,12** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 17,13 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 18,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 19,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 20,13** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 17,14 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 18,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 19,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 20,14** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves
Quadrat 17,15 **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 18,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 19,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves	**Quadrat 20,15** **Species Groups Found:** Bryozoans Sea Cucumbers Sea Urchins Ascidians Bivalves

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Quadrat 1,16 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,16** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,16** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,16** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,17 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,17** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,17** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,17** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,18 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,18** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,18** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,18** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,19 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,19** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,19** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,19** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans
Quadrat 1,20 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 2,20** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 3,20** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans	**Quadrat 4,20** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans

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Quadrat 5,16 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 6,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 7,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,17 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 6,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 7,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,18 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 6,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 7,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,19 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 6,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 7,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans
Quadrat 5,20 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 6,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans Priapulida	**Quadrat 7,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 8,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans

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Quadrat 9,16 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,16** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 12,16** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves
Quadrat 9,17 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,17** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 12,17** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves
Quadrat 9,18 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,18** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 12,18** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves
Quadrat 9,19 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,19** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 12,19** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves
Quadrat 9,20 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 10,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Sipunculids Bivalves Polyplacophorans	**Quadrat 11,20** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 12,20** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves

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Quadrat 13,16 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 14,16** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 15,16** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 16,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 13,17 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 14,17** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 15,17** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 16,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 13,18 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 14,18** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 15,18** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 16,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 13,19 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 14,19** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 15,19** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 16,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 13,20 **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 14,20** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves Barnacles	**Quadrat 15,20** **Species Groups Found:** Bryozoans Sea Cucumbers Sand Dollars Ascidians Bivalves	**Quadrat 16,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves

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Quadrat 17,16 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 18,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 19,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 20,16** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 17,17 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 18,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 19,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 20,17** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 17,18 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 18,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 19,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 20,18** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 17,19 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 18,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 19,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 20,19** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves
Quadrat 17,20 **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 18,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 19,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves	**Quadrat 20,20** **Species Groups Found:** Polychaetes Amphipods Sea Urchins Ascidians Bivalves

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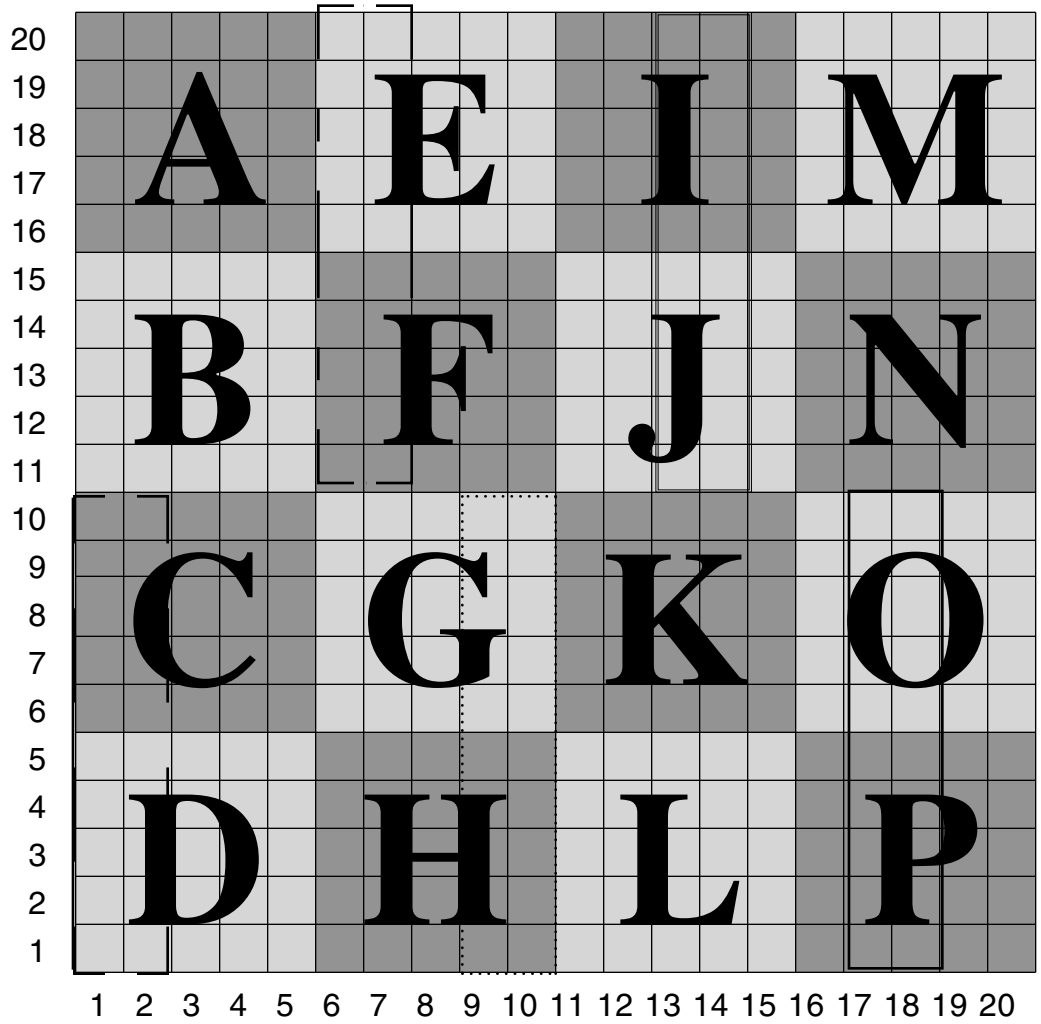
Complete List of All Organisms in the Model Community

All Quadrats in Columns 1 - 5 Contain: **Sand Dollars Sipunculids**	All Quadrats in Columns 6 - 10 Contain: **Sea Urchins Ascidians**	All Quadrats in Columns 11 - 15 Contain: **Sand Dollars Sipunculids**	All Quadrats in Columns 16 - 20 Contain: **Sea Urchins Ascidians**



All Quadrats in Rows 16 - 20 Contain: **Bivalves**

All Quadrats in Rows 11 - 15 Contain: **Bivalves**

All Quadrats in Rows 6 - 10 Contain: **Tunicates**

All Quadrats in Rows 1 - 5 Contain: **Tunicates**

The 25 quadrats labelled C, D, G, H, and L also contain **Brittle Stars** and **Sea Anemones**
The 25 quadrats labelled D, H, L and P also contain **Snails**
The 25 quadrats labelled C, G, K, and O also contain **Isopods**
The 25 quadrats labelled A, B, E, F,, and J also contain **Polyplacophora**

These contain **Polychaetes** and **Amphipods**

These contain **Bryozoans** and **Sea Cucumbers**

These quadrats also contain **Cumaceans**

These quadrats also contain **Priapulida**

These quadrats also contain **Ectoprocta**

These quadrats also contain **Nemertine Worms**

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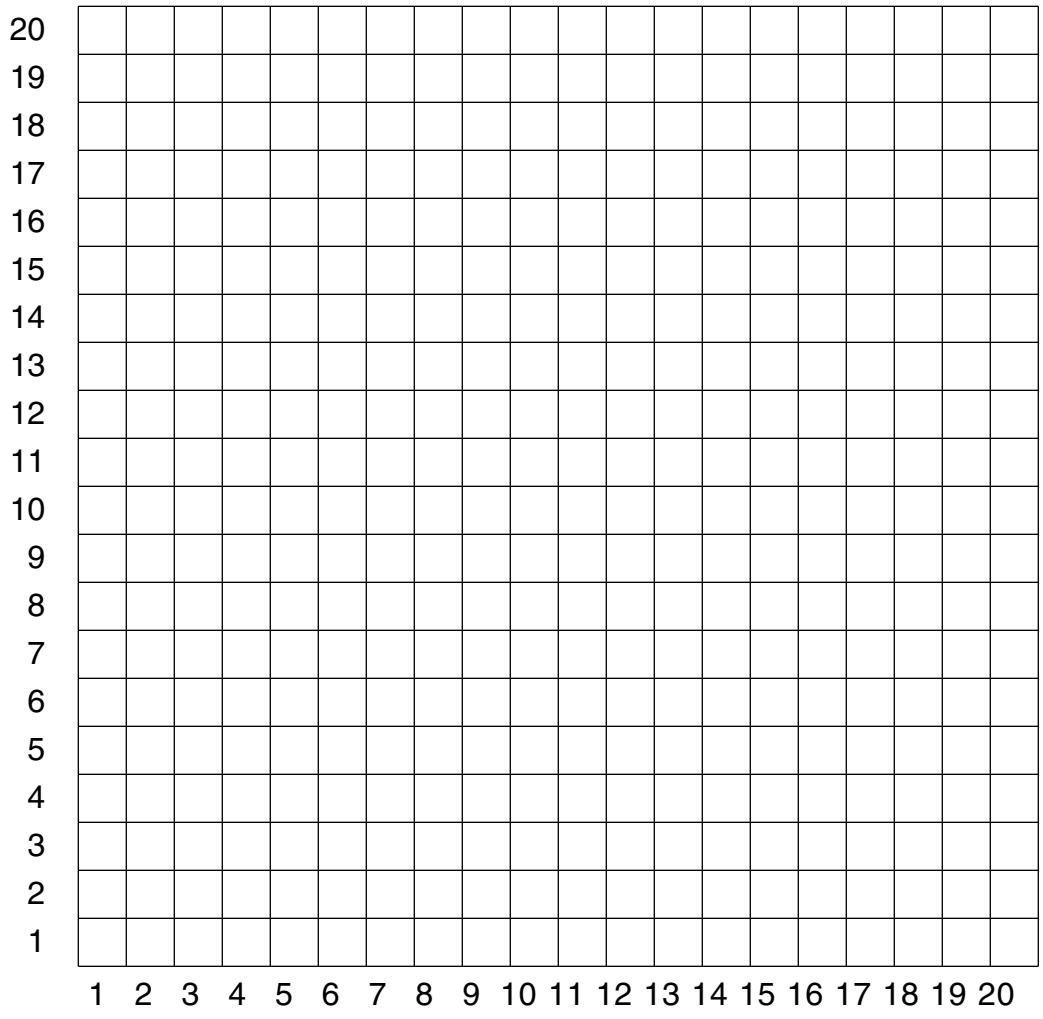
Sampling Plan Sheet

Mark 25 quadrats to be sampled.



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Sampling Plan Data Sheet

Quadrat _____,_____

Species Groups Present:

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Quadrat _____,_____

Species Groups Present:

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Quadrat _____,_____

Species Groups Present:

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Quadrat _____,_____

Species Groups Present:

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Quadrat _____,_____

Species Groups Present:

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Quadrat _____,_____

Species Groups Present:

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Quadrat _____,_____

Species Groups Present:

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