



Science Unit: *Biodiversity & Extreme Environments*

Lesson 3: *Measuring Biodiversity*

School Year: 2009/2010
Developed for: Lord Kitchener Elementary School, Vancouver School District
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Grade level: Presented to grade 5/6/7; appropriate for grades 4 – 8 with age appropriate modifications
Duration of lesson: 1 hour and 30 minutes

Objectives

1. Explore the concept of “biological diversity” or “biodiversity”.
2. Discover different ways that scientists measure species diversity.
3. Practice collecting species diversity data from a mock intertidal community.

Background Information

This lesson introduces the concept of "biological diversity" or "biodiversity". Biologists often define biodiversity as the "totality of genes, species, and ecosystems of a region". However, the most common interpretation of biodiversity is species diversity. Species diversity is a measure of the variety of species which live in an area, and the most basic measurement is “species richness” or the number of species that co-occur in a particular place. Ecologists call this collection of various species which co-occur in a particular place a “community”.

Ecologists measure species diversity to understand which areas are hotspots of biodiversity and thus require special attention for conservation and management. Baseline measurements can also be used to compare the biodiversity status of communities, ecosystems and regions over time and thus are useful tools for assessing changes. Scientists also measure species diversity so they can better estimate whether they have discovered most or all of the species in a particular place. The simplest way to do this is to plot “species richness” against the area sampled – these are called species accumulation curves and the students will build one at the end of this lesson.

The simplest way to calculate species diversity is to determine species richness (the number of species which co-occur in a particular place). However, this measurement only includes the number of species present and says nothing about the relative abundance of the species. For example, if the species richness of a pond is 20, that means that 20 species live in the pond. If Pond A has 20 species, and Pond B has 20 species, we would say they are equally diverse using species richness as a measurement of diversity. However, if Pond A has a total of 1000 individuals and 900 belong to one species, while Pond B has 1000 individuals, but each species is represented by 50 individuals, we intuitively think that Pond B is more diverse. This is because Pond B has a more even distribution of individuals among species - ecologists call this concept “species evenness”. In this example, if scientists had to choose which pond to protect, they would likely choose Pond B because all species are equally abundant (and thus have a better chance for thriving over time) whereas Pond A is dominated by only one species and the other 19 species are relatively rare.

To address this issue of species evenness, ecologists have developed a plethora of diversity indices which include both a measurement of species richness and a measurement of species relative abundance. A very popular graphical representation of species diversity which includes both richness and



SCIENTIST IN RESIDENCE PROGRAM

evenness is the rank abundance curve. Students will create these curves in lesson 4, as well as calculating a well-known species diversity index that also includes aspects of species diversity. In today's lesson students will conduct an activity to understand the difference between species richness and species evenness. Then students will learn how to collect species data from a mock intertidal community and create a species accumulation curve from the data they collect. Today's lesson will prepare them for their field trip in lesson 4.

Vocabulary

Word:	Brief definition.
Biodiversity	The variety of life in a given area (e.g. lake, region, biome or the whole Earth). The most common aspect of biodiversity is species diversity.
Species diversity	A measure of how many different species are co-located in a particular place
Species richness	The number of species co-located in a particular place
Community	The variety of organisms co-occurring in a particular place (typically the extent of the "place" is defined by the ecologist)
Quadrat	A square frame of known area (e.g. 1 x 1 m) used by ecologists to subsample a community
Species accumulation curve	A graph which plots the number of new species found in successive quadrats (subsamples) of a given community. This is a variation of a species-area curve. When the curve reaches a plateau for a few successive quadrats, this is a good indication that most species have been found in that area.

Materials

- 2 jars with coloured beads per group (see instructions below)
- 1 real quadrat
- Worksheet #1a,b,c,d - Mock intertidal communities, 4 versions (1 per group)
- Worksheet #2 (species legend) (1 per group)
- Worksheet #3 (Intertidal zone data collection sheet) (1 per group)

In the Classroom

Introductory Discussion

1. Review the closing conversation from Lesson 2 and discuss the term "biodiversity".
 - What is biodiversity?
 - Why do scientists measure biodiversity? Why is it important?
 - What is species diversity?
 - How do scientists measure biodiversity?
 - What is species richness? Species evenness?
2. Explain that today the students are going to learn how to collect species data from a mock intertidal community using the same techniques that they will use in lesson 4 on their field trip.
 - Show a real quadrat and explain its use in ecological surveys



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- Explain the instructions for collecting species data from their community (see activity #2 below)

Science Activity #1

Activity Title: Measuring species richness and species evenness

Purpose of Activity: To determine the species diversity of two model communities.

Methods and Instructions:

Set-up prior to activity: Prepare 2 jars with different sets of coloured beads for each group of 4. Jar A has 20 beads total - 5 beads of each of 4 colours (e.g. red, blue, yellow, green). Jar B has 20 beads total – 17 beads of one colour (e.g. red) and 1 bead of 3 colours (e.g. blue, yellow, green). Explain that each colour is a species and each bead is an individual. Divide students into groups of 4.

1. Each group gets one Jar A and one Jar B. Ask the students to discuss which jar is more diverse and report back to the class about their choice. They need to explain why they choose Jar A or Jar B to be more diverse (or if they say their jars have the same diversity, they need to explain why).
2. The teacher records the student group answers on the board.
3. Each group returns to their jars and calculates “species richness” and the number of individuals per species. The results are written on the board for one group and the teacher discusses the difference between species richness and species evenness (see paragraph below).

The teacher then explains that one way scientists measure species diversity is to count all the species that co-occur in a community. This measurement is called “species richness”. Both Jar A and Jar B have the same # of species, so using this measurement of biodiversity they are the same. However, we intuitively think that Jar A is more diverse because there are an equal number of individuals per species, rather than one species being very dominant. To include this concept of “species evenness” scientists have developed other measurements of species diversity that include not only the number of species present, but a measure of how individuals are distributed among species. Thus, Jar B is actually more diverse if we consider Species Evenness (how individuals are distributed among species)

Science Activity #2

Activity Title: Measuring species diversity in a mock intertidal community

Purpose of Activity: To collect species diversity data from a mock intertidal community in order to prepare for lesson 4 (intertidal zone field trip).

Methods and Instructions:

Set-up prior to activity: Divide students into groups of 3 or 4 so that you have 8 groups for the class. There are 4 versions of the mock intertidal community (see attached “Worksheet 1a”, “Worksheet 1b” etc.) and each version has the quadrats located in different places. Print the mock intertidal zones on large paper (ideally about 3 feet by 2 feet) and give version 1 to two groups, version 2 to two groups etc.

Demonstration: Begin activity with a 5-10 minute demonstration of how to collect and record the species data using one of the mock intertidal communities. [Note: each mock community drawing already has 3 quadrats superimposed on it.] Explain that students will record the number of individuals present (abundance) for some species (e.g. sea stars, mussels), while for other species (e.g. encrusting algae)



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and non-living substrates (e.g. sand, rock), we record the percent cover occupied by that species/substrate.

1. In groups (3-4 students/group), students observe the species in their drawing of an intertidal community. They use their field guides to make a "Species Legend" (Worksheet #2) – they draw the animal or plant and assign the proper common name. Note that the animals and plants in the mock intertidal zone drawing are general types (e.g. barnacles, anemones etc.), so students need not worry about identifying down to species.
2. The mock intertidal zone has 3 sample quadrats superimposed on it. The following are the student roles and the sequence of collecting species diversity data within each quadrat (Worksheet #3):
 - i. The first student counts the number of individuals per species for the species being recording with abundance data.
 - ii. The second student estimates the percent cover of the remaining species (e.g. encrusting algae) and substrates (e.g. rock, sand etc.).
 - iii. The third student is the "data recorder" and writes down all the observations on the data sheet (Worksheet #3).
 - iv. If there is a 4th student, then s/he helps the data collectors.
3. After all the data has been collected and the first two pages of Worksheet #3 completed, then students work together in their groups to create a species accumulation group (third page of Worksheet #3). Note that students need to read the instructions carefully!!

Closure Discussion

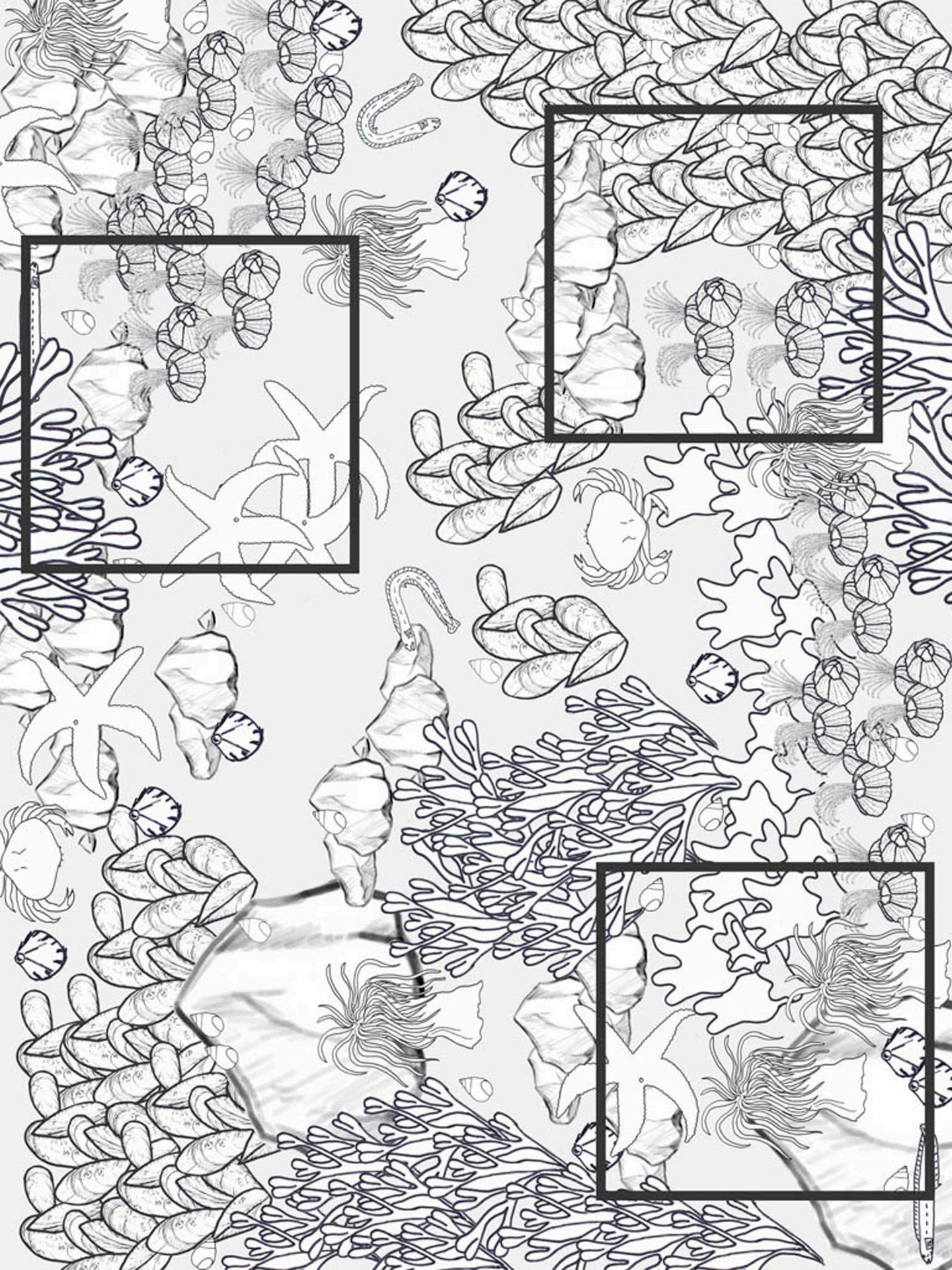
1. Ask students to present their species accumulation curves to the class. End by asking students if they have any questions about the field trip next week and data collection protocols.

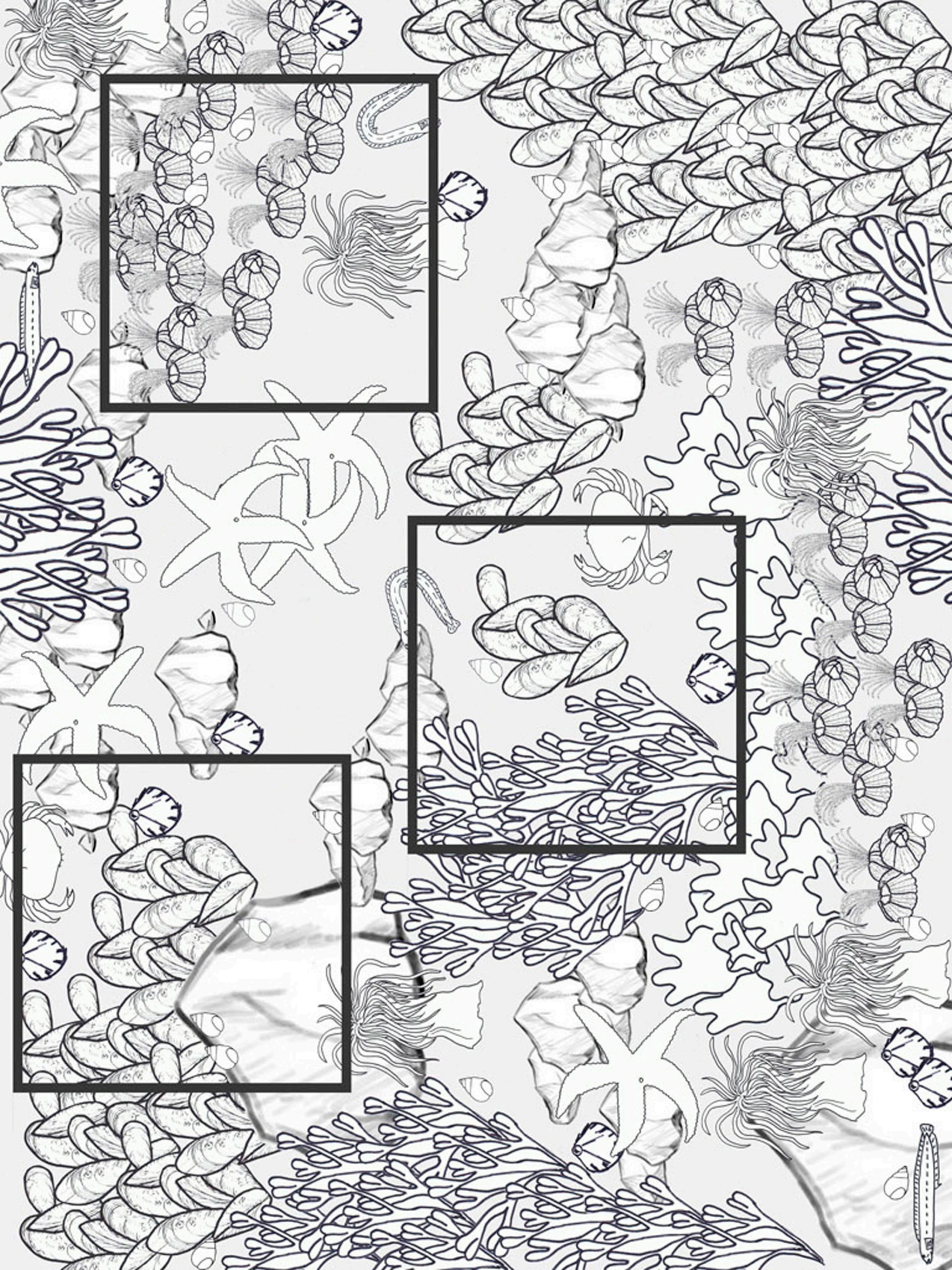
References

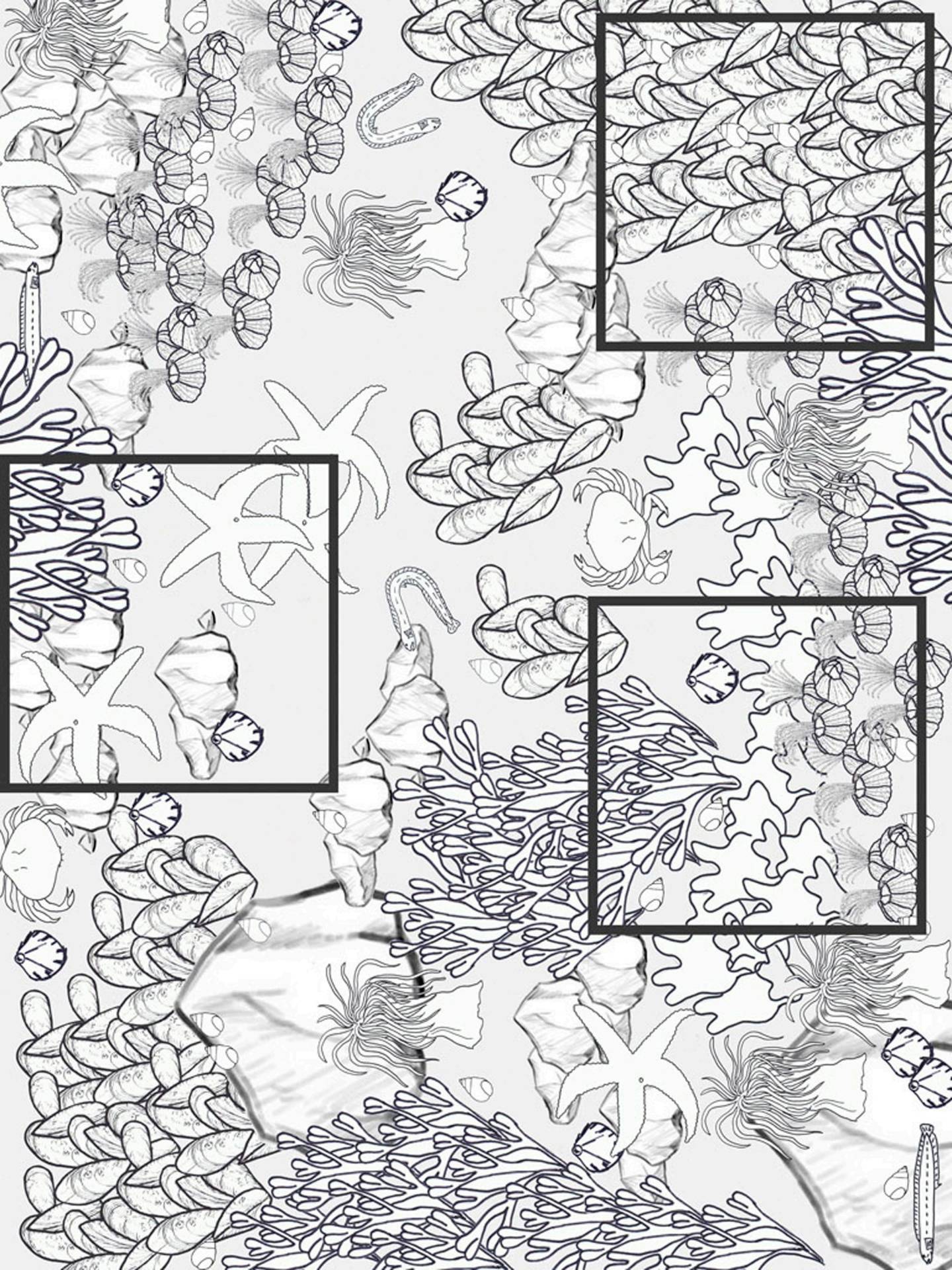
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5. <http://www.ecotoxicology.ca/csi/MainPage.html> Coastal Scene Investigation - Shannon Bard's Ecotoxicology Lab. [notes on sampling BC's intertidal communities]. Accessed March 2010.

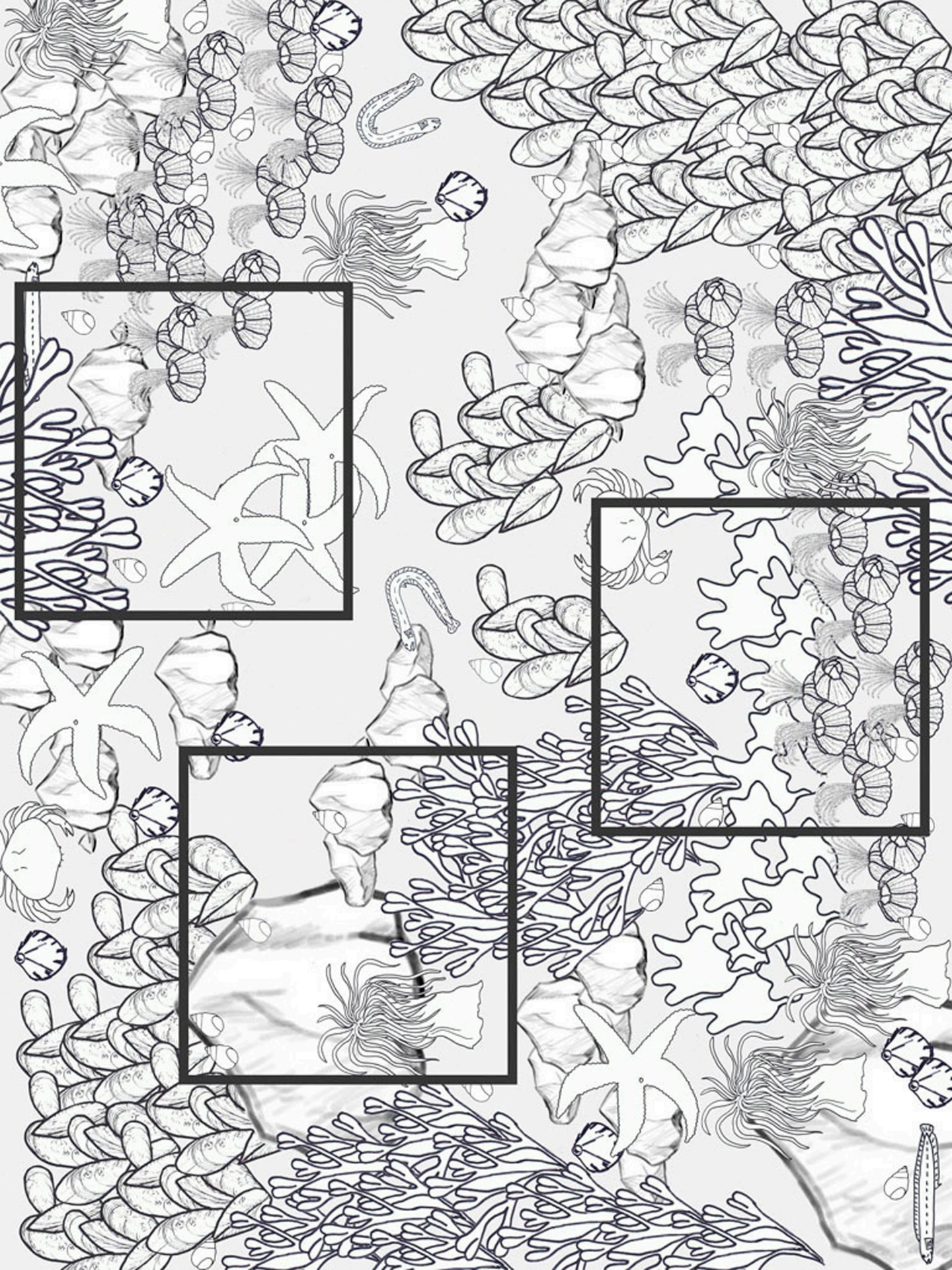
Extension of Lesson Plan

1. Review the field guides and read about the common species in preparation for lesson 4.

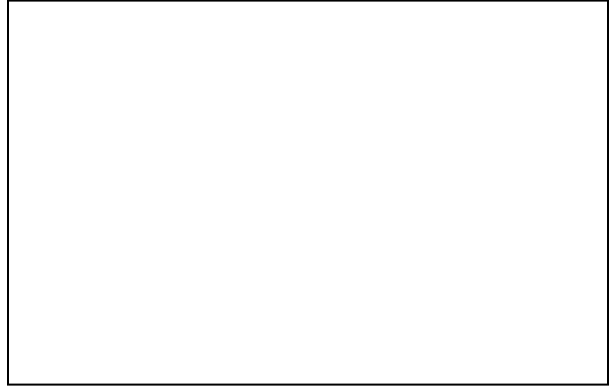
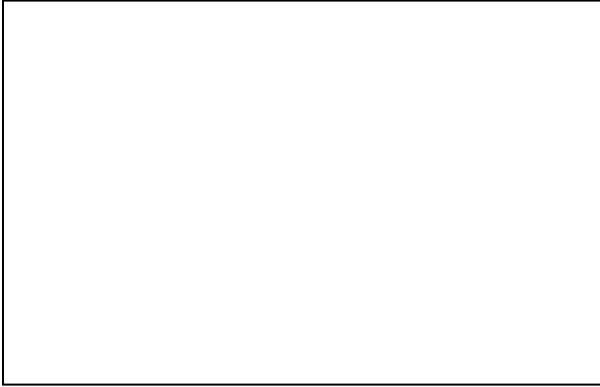








Species Legend



Names: _____

INTERTIDAL DATA COLLECTION SHEET

Quadrat A

Species	#	Seaweed, Rock or Sand	% cover
Species richness =			

Quadrat B

Species	#	Seaweed, Rock or Sand	% cover
Species richness =			

Quadrat C

Species	#	Seaweed, Rock or Sand	% cover
Species richness =			

Names: _____

Add together your observations from the 3 quadrats to calculate the Total Community Abundance and the Rank of each Species

- List each species and its abundance per quadrat (A,B,C)
- Add up the total number of individuals for each species (Total)
- Add up the Totals for each species to calculate the "Total Community Abundance" (# of total individuals counted in all 3 quadrats)
- Rank the species from highest to lowest abundance within the community

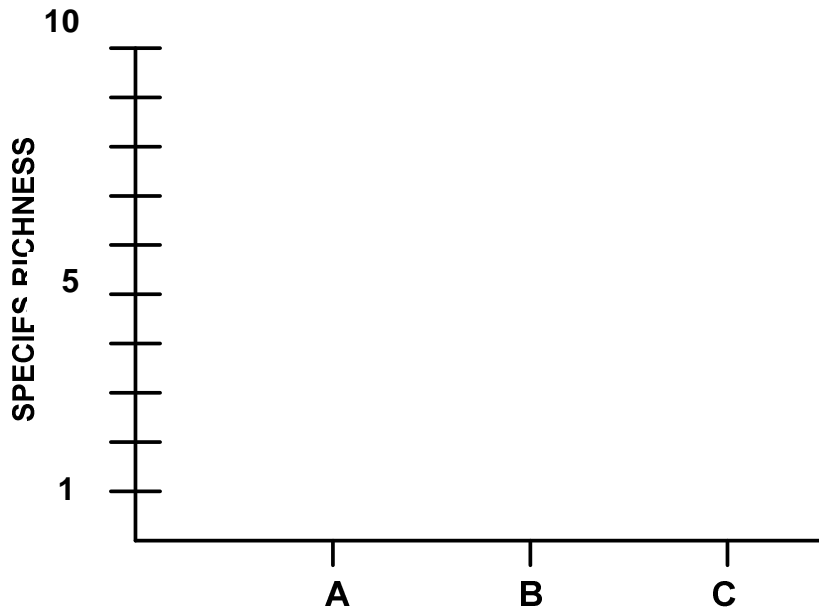
Species	A	B	C	Total	Rank
Total Community Abundance					-

Seaweeds	A	B	C	Rank
	%	%	%	
	%	%	%	

Names: _____

Make a Species Accumulation Graph

- Graph the “species richness” (# of species) you found in Quadrat A.
- Determine the # of NEW species you found in Quadrat B. Add this # to the # of species found in Quadrat A to calculate the “species richness” of both A and B.
- Determine the # of NEW species you found in Quadrat C. Add this # to the # of species found in Quadrats A+B to calculate the “species richness” of all 3 quadrats.
- Connect the dots.



What happened to “Species Richness” as you increased the number of quadrats you observed? Hint: look at your graph!

What do you think would happen to “Species Richness” if you observe more quadrats? Why?

How do ecologists know if they have found all the species in a particular place?
