Science Unit: ***Marine Pollution***
Lesson 2: ***Scientific Sampling***

School year:	2006/2007
Developed for:	David Oppenheimer Elementary School, Vancouver School District
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Grade level:	Presented to grades 4-5; appropriate for grades 4-7 with age appropriate modifications.
Duration of lesson:	1 hour and 20 minutes
Notes:	Extension activities pre- and post-lesson

Objectives

1. Learn how scientists take samples in two dimensional space.
2. Learn about extrapolation, patchiness, and sampling bias.
3. Make quadrats for use on a subsequent field trip and practice using them.
4. Practice stating results and drawing conclusions, based on data from sampling.

Background Information

Scientists collect samples and data in order to answer their questions. Their results and conclusions depend on the quality of their sampling and the assumptions that go into sampling. Unfortunately, it is impossible to truly sample and measure the whole world! So scientists have to sample/measure parts of the world, then extend their observations to a larger area. Marine scientists have a particularly hard time because the ocean is so vast and it's difficult and expensive to go out in ships to sample it. So, they sample tiny parts of the whole and then they extrapolate. For example, if scientists want to figure out how many salmon (or squid, or crabs) are living off the coast of British Columbia, they can't catch and count all the individuals. Instead, they count the number of salmon/squid/crabs in a small area (or areas), then assume that other similar areas (which they didn't sample) also have similar numbers of salmon/squid/crabs. If you wanted to know how many chocolate chips (total) went into making 100 chocolate chip cookies, you could count the number of chocolate chips in just one cookie, then multiply by 100.

A common technique for sampling an area on land reasonably well (without taking forever), is to use a quadrat (typically a 1-m square frame) to easily define an area to subsample. Set it on the ground and carefully collect all items of interest (or make detailed observations) within its boundaries. Often scientists will simply make observations without taking samples away. For example, one might identify all the plants living within that square meter in a marsh. If a scientist made observations within several quadrats, arranged on a transect line, they might be able to tell how the community of marsh plants changes with distance from a relevant feature (like a tidal channel, or the high tide line)..

Vocabulary

<u>Quadrat:</u>	A square frame (made of any rigid material), usually 1 meter on a side.
<u>Uniform:</u>	The type of pattern you'd see if all the items you're sampling are spread out evenly in space.

Patchy:	The type of pattern you'd see if all the items you're sampling are bunched up together in small groups.
Extrapolate:	Extend observations to similar areas that were not sampled.
Sample:	Any item of interest that is counted, measured, or observed.
Abundant:	Definitions vary for "abundant", "common", and "rare". For our purposes, we'll consider something "abundant" if it makes up more than 30% of all the samples
Common:	When a certain type of item makes up between about 5% and 30% of all samples
Rare:	When a certain type of item makes up less than 5% of all samples
Replication:	Repeating observations or measurements, in this case, in a slightly different place. If your replications agree, then you gain confidence that your observations are representative. You can average your replications to gain more confidence.

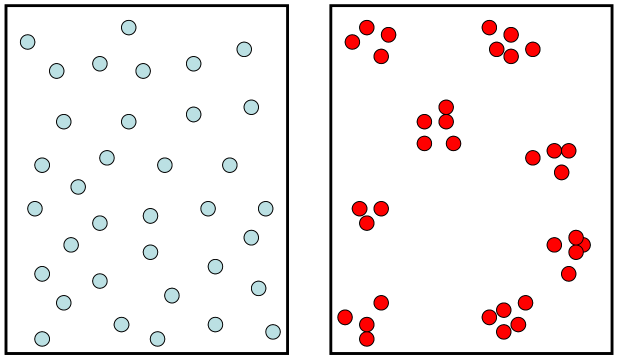
Materials

- Materials to make quadrats for every 2 students (3/4 inch PVC pipe and PVC "elbows" work very well. One 10-foot length of PVC will make a quadrat that is a good size for handling (though not quite a square meter!)
- 2 kg of one type of dried bean (type A, e.g. small white beans), representing an "abundant" type of sample, to distribute uniformly.
- 1 kg of dried bean type B (e.g. pinto beans) slightly "less abundant", to distribute in a patchy pattern.
- 500 g of dried bean types C and D (e.g. small red beans and yellow split peas) to represent "common" samples, one distributed uniformly and the other in a patchy pattern
- ~50 pieces of dried bean type E (e.g. large lima beans), to be something "rare" distributed in a patchy pattern.
- ~8 pieces of dried bean type F (e.g. small green mung beans) to be distributed approximately uniformly. Keep this "mystery" one out of the example cups.
- Small paper or plastic cups for each pair of students, to hold their example beans
- Small pieces of wrapped candy, one for each student: chocolate kisses, caramel, starburst…one abundant, one common, one rare.
- Long measuring tape for setting up sampling area.
- Wide tape (duct, masking) to mark off a sampling area.
- "Do not disturb" signs if setting up in a public place.
- A small plastic dinosaur or other strange object
- Copies of the data sheets, one per student

In the Classroom

Introductory Discussion

1. How many fish are in the sea? How might you go about finding out? What would you need to know in order to make a good estimate?
2. How many desks/pencils/scissors are there in the room? How might you find out? How many desks/pencils/scissors are there in the school? How could you estimate the number without disturbing all the other classes?
3. Discuss uniform versus patchy distribution. For a demo, you could have one overhead with a uniform distribution of blue dots and another overhead with a patchy distribution of red dots. Show them individually, then overlay them both. Or you could draw on a newsprint pad.



a. Ask students to arrange themselves in the classroom in a uniform distribution

b. Ask students to arrange themselves in the classroom in a patchy distribution.

4. Discuss common versus rare. For a demo, you could have each student draw one item from a bag (or hand an item to each student). In the bag will be 90% one type of item, 9% another type, and 1% a third type (e.g. chocolate kisses, starburst, caramel). After all the students have drawn something out of the bag, have them find everyone else who has their same item. One large group will form, one small group, and one student will be the only person with the rare item. Discuss.

5. Discuss vocabulary.

6. Briefly describe activity.

7. Review scientific method, particularly sampling, observations, results, conclusions

Science Activity/Experiment

Activity Title: Sampling with quadrats

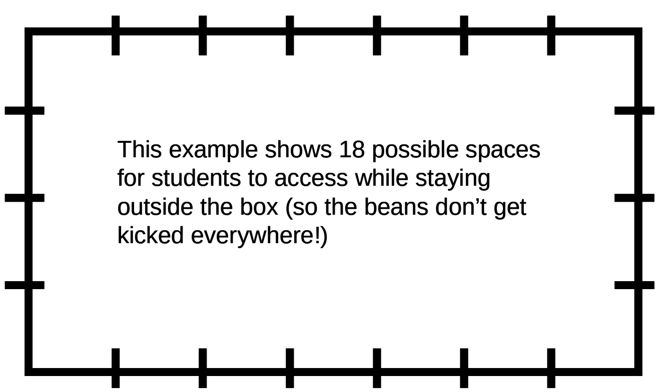
Purpose of Activity: Learn about spatial sampling and practice using quadrats.

Experimental Observations: This is not an experiment with controls and treatments. Students will sample different types of sample distributions and extrapolate their data to draw general conclusions.

Methods:

Set-up prior to experiment (Ideally, this would be done outside or in a room with a smooth floor):

(1) In part of the classroom, or outside, set up the sampling area (~10x10 meters, or less if there's not that much space in the classroom). It's helpful to "tick" off units of the quadrat size to help students place their quadrats. Here's a diagram of what the taped area could look like:



(2) Distribute the bean types as follows:

Type A (small white beans): uniform and abundant.

Type B (pinto beans): patchy and less abundant (but still abundant).

Type C (small red beans): uniform and common.

Type D (yellow split peas): patchy and common.

Type E (large lima beans): patchy and rare.

Type F (green mung beans): ~uniform and very rare (this is the mystery bean – don't tell the students about this one). You could also add something else even more rare (e.g. a small toy dinosaur), with just one item in the sampling area. Put this very rare item in the middle of the sampling area where the student quadrats will NOT actually sample.

(3) For every pair (or 3 if needed) of students, make up an "examples cup" – a small cup containing one example of each type of bean, except Type F.

ACTIVITY:

Students will work in groups of 2 (a few groups of 3 is fine). In their lab notebooks, or on data sheets, they should record today's date and lesson title.

1. Make quadrats. Using 4 lengths of PVC pipe and 4 "elbow" fittings, make a square frame. They can come apart again fairly easily, for storage. These will be used during the field trip later.
2. Prepare data sheets. Make a species key. Draw a colored picture of each type of bean in the "examples cup" in the space on the data sheet. Try to approximate the size and shape, since some of the beans are the same color.
3. Use quadrats. Take quadrats to the sampling area. Work in groups, 2-3 students per quadrat.
    a. Have students stay OUTSIDE the boundaries of the sampling area. Carefully set the quadrats on the ground, at the inside edge of the sampling area. If your area is small, the taped tick marks will help guide students so that everyone can get a space. Try not to step on or move too many samples!
    b. Without moving or disturbing any of the samples inside the sampling area or inside your quadrat, count the numbers of all the different types of samples (beans) in your quadrat. Record the numbers on the data sheet. Make notes about anything unexpected or unusual. If it's taking too long to actually count one type, encourage students to estimate.
    c. Repeat in two other places within the larger sampling area. (Teacher can call when students should switch to new places). Record the numbers on the data sheet.
4. Calculate the average composition of one "square" (equal to the area covered by one quadrat) within the sampling area. Record on data sheet. For example, for "Species A", students should add together their counts from quadrats 1, 2, and 3, then divide the total number by 3 (for 3 quadrats sampled). Calculate and record this average for each species individually. You could write student results on the board and compare/discuss, since they will all get somewhat different results
5. Extrapolate the average quadrat/square composition to the whole sampling area (multiply the average composition (by species) by the number of "squares" in the whole area). How many total of each species?
6. If there's time, you could sweep up all the beans and get the students to sort and count all of them to test their extrapolation.

Closure Discussion

1. Which items were abundant/common/rare? Which items were distributed uniformly? Which ones were patchy?
2. Did it matter where you sampled? Did you get the same result when you sampled different places?
3. Did you find anything unexpected? A new species? What was its distribution?
4. How could you check if your extrapolation was good? (you could sweep up all the beans and count ALL the samples in the whole area). Can you check your extrapolation in the whole ocean?
5. You only sampled around the edges. What do you think was in the middle of the sampling area? What if you only sample around the edges of the ocean? Can you extrapolate to the middle?

References

1. http://www.countrysideinfo.co.uk/howto.htm for thorough information about quadrat use in ecological sampling.
2. http://ed.fnal.gov/samplers/prairie/pp_previsit_quad_study.html for an example of a lesson plan sampling in a school yard.
3. http://www.georgiastrait.org/quadrat.php for the Georgia Strait Alliance's project on BC's beaches, using quadrats.
4. http://livingprairie.ca/livinglandscape/quadrats/quadrat.html?q=3 for a time-lapse movie of changes in vegetation on a prairie landscape within a quadrat over the course of a year.

Extension of Lesson Plan

1. As noted above, you could check how well the extrapolation works by sweeping up all the beans, sorting them, and counting each type, perhaps on a different day. Compare student single quadrat data, and average quadrat data to the total actual count.
2. You can use this sampling technique for any kind of spatial data, depending on the scale of items of interest. Possibilities include: observations of the different types of plants in a park, forest, or on school grounds, different types of shells or animals at the beach, different types of tree leaves on the ground in the fall. The next lesson in this series uses quadrat sampling for plastic pollution on a beach.

Student Data Sheet – Scientific Sampling

Name: ______________________ **Date:**______________

SPECIES KEY

	Type A	***Type B***	***Type C***	***Type D***	***Type E***
Drawing					

QUADRAT 1 DATA (how many of each?)

Type A	***Type B***	***Type C***	***Type D***	***Type E***

QUADRAT 2 DATA (how many of each?)

Type A	***Type B***	***Type C***	***Type D***	***Type E***

QUADRAT 3 DATA (how many of each?)

Type A	***Type B***	***Type C***	***Type D***	***Type E***

AVERAGE DATA (add up the total from all three quadrats, then divide by 3)

Type A	***Type B***	***Type C***	***Type D***	***Type E***

Type A	*Type B*	*Type C*	*Type D*	*Type E*

EXTRAPOLATED TOTAL DATA – How many **TOTAL** of each type in the **WHOLE AREA?**

How many squares in the whole area? ___________________________________

(Extrapolated total data = AVERAGE DATA x total number of squares)

Type A	*Type B*	*Type C*	*Type D*	*Type E*

1. Which types were:

abundant? ______________________________________

common? ______________________________________

rare? ____

2. Which types were distributed :

uniformly? ______________________________________

patchy? ____

3. Did it make any difference where you sampled? _________________________________

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4. Did you find anything unexpected? ____

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