Species Richness: Card Safari

<u>Concepts: graphing, search effort, standardization, and probability</u>

Modified by Joanna Philippoff from lessons developed by Erin Baumgartner and Chela Zabin

Introduction:

Species richness is the number of different species in an area. Richness does not tell us anything about the relative abundance of these different species, but simply lets us know how many species are found in an area. This activity helps prepare students to make a general search, focusing sampling effort and standardizing techniques.

Methodology:

To represent different species, you can use multiple decks of cards and have different cards (e.g. ace of diamonds, king of clubs, two of hearts, etc.) represent different species. However, it's fun to use index cards with the names of species from a field site your class will visit. This activity works well with about 50 cards representing twelve species of varying rarity (Table 1). Table one has examples of species to use if you are planning to conduct an intertidal study in Hawaii. The card abundances are similar to the representative species abundances in the field. For example, it would be rare to find an octopus on a field trip, but periwinkles and nerties are very common.

Table 1: Proportion of species in card safari game

Number of species	Number of individuals per species	Examples of Species from the Intertidal	Total
3	1	Octopus, Tiger Cowrie, Spanish Dancer	3
3	2	Cone snails, Urchins, Opihi	6
2	3	Seahares, Oysters	6
2	5	Drupes, Brittle Stars	10
1	10	Periwinkles	10
1	15	Nerites	15
12			**50**

Setting the Scene (Pre-activity Discussion):

Tell your students to imagine a scenario: Let's say there are 500 different species at our study site. Some are large and abundant and obvious, but most are small, hidden or rare. Our class goes there to do a field survey, but we get a late start and we only have half an hour.

- *Do you think we can find all 500?*

Let's say we have the opportunity to return another day, and this time we have 1 hour.

- *How do you think our list of species compiled on the second day will compare with the first?*

We decide to go back one more time. This time we have 2 hrs.

- *How do you think our species list will compare to the first two times?*
- *What do you think is the relationship between time spent looking and the number of species found? Does it go up indefinitely? Could we graph that?*

Have the class make a prediction about the amount of time spent searching and the number of new species that will be found. Most of them will probably agree that over time, the number of new species found will decrease, and that the number of total species found will diminish and level out. It is useful to have them draw a graph that describes their prediction of the total number of species that will be found over time. The process can then be modeled using this simple card game, where the classroom represents the intertidal area and the cards are the species we are looking for.

Card Safari

Have four students leave the room, and let the rest hide the cards around the room. Then the four students can come back in and search for 30-second intervals for 5 or 6 trials. Following each interval, record the total number of species found so far (Table 2). As you can see, over time the number of *new* species found deceases even though cards of all species are still being captured. Graph the total species found against the amount of time spent searching (Figure 1). This figure is called a rarefaction curve. Scientists examine the shape of the curve to determine when a search can reasonably be terminated. When the curve flattens out at its highest value, at approximately 150 seconds in our example, although there may still be species left to be found, the majority have probably been discovered and the relationship between additional time spent searching and number of new species found is likely to be minimal. Therefore we can assume that if the cards were hidden again in a similar way and if similar students searched the area again, we could stop the search at 150 seconds and assume we had found the majority of species in an area.

Replicate the game at least once with another team composed of four different people searching.

- *Are the results similar?*

Table 2: Data from student searches for new species of cards hidden in the classroom

Interval	Cumulative Time	Species found	New species found	Total species found
0	0	0	0	0
1	30 s	4	4	4
2	60 s	6	2	6
3	90 s	5	2	8
4	120 s	4	1	9
5	150 s	4	1	10
6	180 s	3	0	10

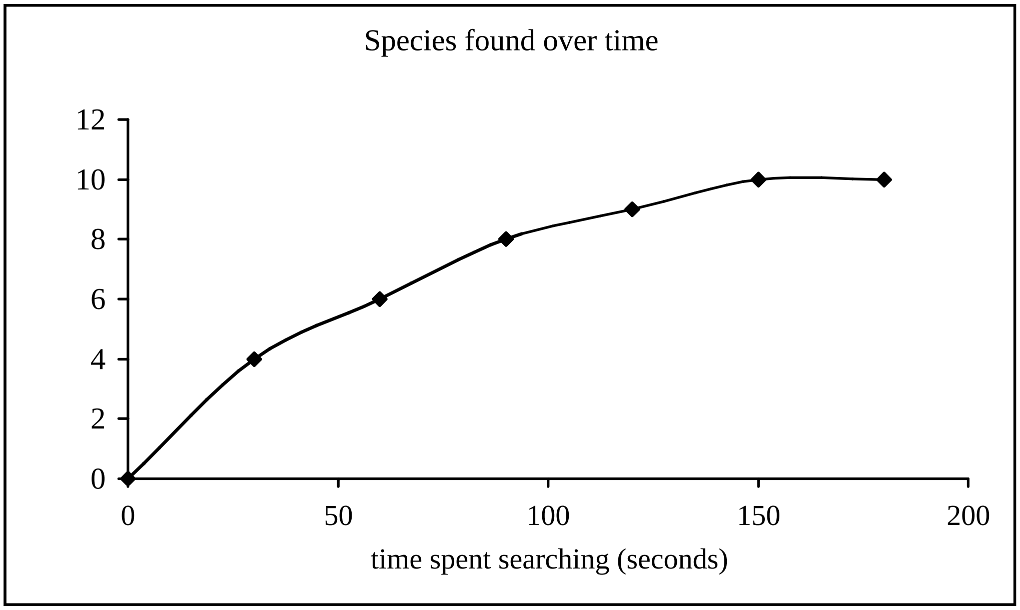

Figure 1. Graph of total species found over time spent searching from the card safari game.

Explaining the Game:

Hiding Rules:

- It is useful to have "hiding rules" in place, to keep the search safe and as tidy as possible. Explain that one of the most basic rules in searching for species in the intertidal is not to destroy habitat. If you roll a rock over to look underneath it, you must put it back exactly the way it was. In the classroom, if you lift up an object to look underneath it, you must put it back.
- Those who are not searching should observe how the searchers are looking – but without helping. In the intertidal water will cover much of our study site and create an added challenge when looking for species. By not helping – we are keeping the search realistic!

30-Second Intervals:
We suggest 30-second intervals during the card safari based on past observations of how well students hide cards compared to how well they search for them. If your students hide the cards in difficult places, you may have to increase the interval to one minute. If your students find all the cards in just a couple of trials, you should decrease your intervals to 15 seconds each to graph a more realistic rarefaction curve.

Variations:

Safety Hazards:
The longer we search in for species in the intertidal, the more likely someone is to get hurt – even if we are careful. You can model this by adding two more cards to the deck of species: a "bitten by moray eel" and a "stung by cone snail" card. These cards should be hidden like the rest of the species, but when searching the area the student(s) who find these cards have to immediately stop searching and "go to the emergency room" (e.g. sit back down in their seats). Although most intertidal species can be safely handed, moray eels and cone snails are two potentially hazardous intertidal species students have to be aware of in the field.

Effect of Number of People Searching:
To examine the impact of the number of people searching, have seven students leave the room, and allow others to hide cards. Have 1 student come back in and search for 30 second or one minute intervals for 5 or 6 trials. Record how many species they find and then re-hide those cards (in the original places if possible). Then have two students enter and search for the same time interval in the same number of trials. Record and re-hide. Have the last four students enter the room and search for the same time interval and number of trials. By making sure all the time intervals are the same, the only change is in effort is due to the number of searchers, rather than by time spent searching. Students can graph the number of species found versus the amount of time spent searching by different numbers of people.

Effect of Search Area:

- To simulate the effect of searching over different sized areas, vary the space in which students can search. One team of four can be restricted to an area ¼ the size of the room, and a second team can search the other ¾ of the room. Keep intervals and number of trials the same for each team.
- You can also restrict where people search (*i.e.,* no bookshelves) to get at the effects of ignoring some types of habitats. You should not let the students know which areas will be restricted until after the cards are hidden, so species may – or may not – be in the restricted areas.

Effect of Species Distribution:
When students hide cards without instructions on how or where to do so, we have been assuming the cards are hidden randomly around the room. However, many species are not evenly spaced in the field. In the intertidal some species cluster in the high intertidal while others cluster in the low intertidal, creating different ecological zones that lie in bands along the coast (for a more detailed discussion see "Learning How to Lay Transects" in the Measuring Abundance lesson). This can be simulated in the classroom by clumping cards of the same species. This can be done with structures, e.g. hiding all the periwinkle cards on bookcases, or in bands, e.g. hiding all the drupes cards at the front of the room or all the nerite cards very low to the ground.

End Note:

These kinds of searches may be especially useful in determining the richness of an area, but they are not as useful for quantifying the number of each type of species. For example, students may find one organism at multiple sites, but at some sites that organism may be very abundant, while at other sites only one individual of that species might be found. General search data of only species numbers does not reveal much about these relative proportions. More quantitative methods, such as the use of transects and quadrats, are required to measure abundance.

Questioning strategies:

How could you know if you found all the species in a given area?
You may never know completely, especially for rare or very cryptic things. One thing scientists do is look at a rarefaction curve. They look at the number of total species found over time. When the curve starts to level off, the assumption is that most species have been found.

Why are some species harder to find? Why didn't we find all the species?
Some may be better at hiding (or in the case of the cards, hidden by a student who is really good at hiding them), or are very rare. When you're out in the field looking for actual organisms, some may be very fast, and others may only come out at night..

What would happen if the searchers got help from the class?
Not only is this unrealistic, in the field the students will not be omnipotent and be able to locate all the species, but helping would also affect the results by changing the shape of the rarefaction curve. The rarefaction curve would have a steeper slope in the beginning, and flatten out at the maximum number of species more quickly.

What would happen if we searched two different areas for different amounts of time, or with different numbers of people? Could we compare our results with any certainty?
We could not make a straight comparison. This question gets at the idea of standardization -- that things should be as similar as possible in a study to make comparison easy and appropriate. The point here is that when students are planning a study, they should standardize as many things as possible (e.g. time, people, area, search techniques).

Could we figure out a way to make comparisons even though we did some things differently?
This question gets at the idea of how to standardize data even if the conditions under which the data were recorded vary. One way to do this is to use catch per unit effort (CPUE). This is a common way to represent data collected from a variety of sources in many different situations, such as in fisheries, where many different types of boats using different types of gear are catching the same species of fish. Some typical measures of CPUE used in fisheries are net hours (number of fish captured divided by total time all nets on a boat spent in the water) or boat hours (number of fish captured divided by time spent fishing). To standardize intertidal studies, you could divide the total number of species found by the number of people searching or the number of minutes spent searching and get a catch per unit effort rate (CPUR).