

Counting Dune Plants: Richness, Evenness and a Diversity Index

Learning target: I can calculate species richness, proportions and Simpson's index of diversity from sample counts, graph the results, and use them to describe how an invasive plant changes a dune community.

Data and graphing

About 45 min

Individual

MS-LS2-4 · practice

MS-LS2-5 · supports

data analysis

independent practice

Name _____

Date _____

Period _____

Directions

The dataset is a teaching dataset: the numbers were invented to be realistic, not measured at a real beach. Read the scenario, then work through Parts A to C. Use a calculator, show every calculation, and round proportions to two decimal places and squared proportions to four decimal places. Draw the graph with a ruler.

You will need: This worksheet, Pencil, Ruler, Calculator

The scenario

Highway iceplant is a succulent from South Africa that people planted along California roads and coasts to hold soil in place. It spreads into thick mats that cover the sand. A park science team sampled plants at three dune sites on the same stretch of coast. At each site they laid five quadrats (square frames 1 meter on a side) and counted every rooted plant inside them. Site A is a dune where volunteers removed iceplant ten years ago. At Site B iceplant is spreading. Site C has been covered by iceplant for decades.

Rooted plants counted in five 1 m × 1 m quadrats at each site (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Plant	Native or invasive?	Site A	Site B	Site C
Beach bur	native	14	8	2
Yellow sand verbena	native	12	4	0
Beach primrose	native	10	6	2
Silver beach lupine	native	8	2	0
Beach morning glory	native	6	0	0
Highway iceplant	invasive	0	30	36

Simulated data for teaching. The plants are real California dune species, but the counts were invented. Real surveys of mat-forming plants often measure the percent of ground covered instead of counting plants.

How to calculate Simpson's index of diversity — 1. Add the counts to find the total number of plants at the site. 2. For each species, find its **proportion**: its count ÷ the total. 3. Multiply each proportion by itself (square it). 4. Add all the squared proportions. 5. Subtract that sum from 1. The result is Simpson's index of diversity. It is close to 0 when nearly every plant belongs to one species and gets closer to 1 when there are many species in similar numbers. It also has a meaning you can picture: it is the chance that two plants picked at random (putting the first one back before picking again) are **different** species.

Part A: Richness and proportions

- Complete the summary table for each site.

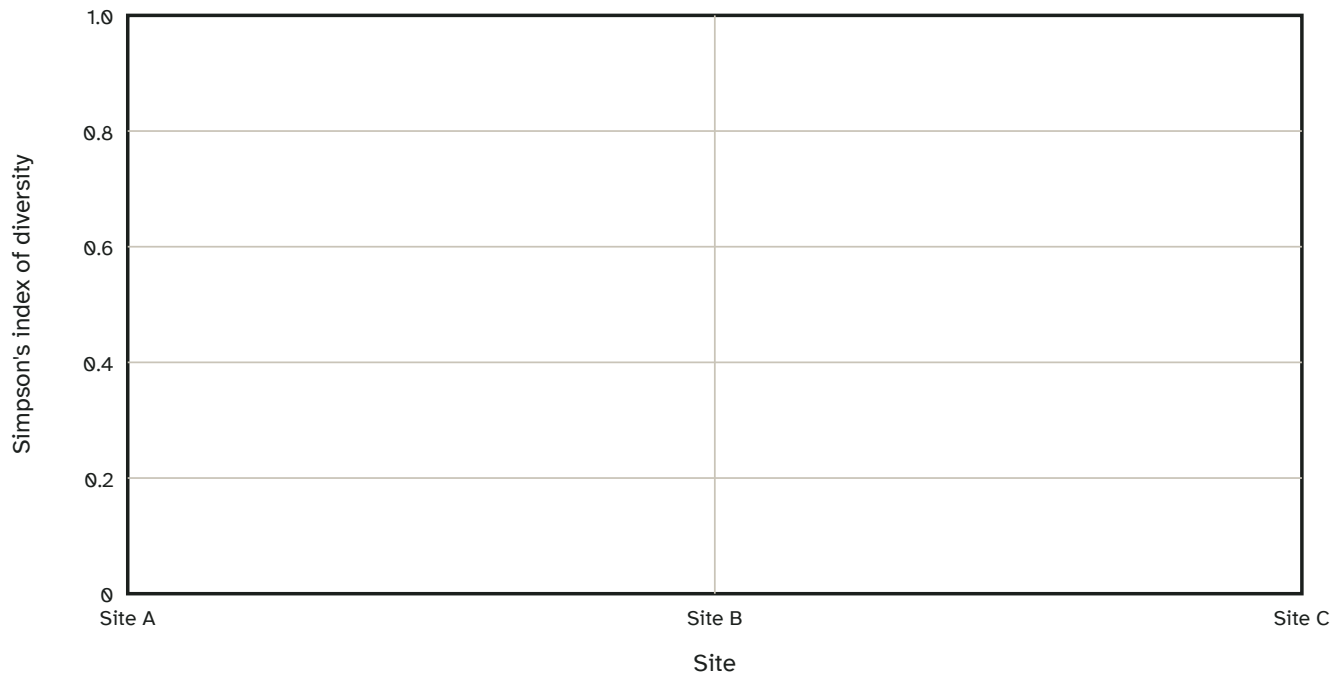
Total plants counted	Species richness (all species)	Native species richness	Percent of plants that are iceplant
Site A			
Site B			
Site C			

- Calculate Simpson's index of diversity for Site A and Site B. Fill in the proportion and the squared proportion for every plant, then the sum and the index. Show one proportion calculation below the table.

Site A proportion	Site A proportion squared	Site B proportion	Site B proportion squared
Beach bur			
Yellow sand verbena			
Beach primrose			
Silver beach lupine			
Beach morning glory			
Highway iceplant			
Sum of squared proportions			
Index (1 – sum)			

- Calculate Simpson's index of diversity for Site C. Show each step.

Simpson's index of diversity at three dune sites



Part B: Interpret

4. Draw one bar for each site on the graph. Describe the pattern from Site A to Site C in one or two sentences, using your three index values.

5. Sites A and B have the **same** species richness. Explain why Site B's index is much lower. Use the word *evenness* and at least one proportion from your table.

6. The sum of squared proportions is the chance that two plants picked at random (with the first put back) are the **same** species. What is that chance, as a percent, at Site A and at Site C? Explain what the difference means for someone walking across each dune.

7. A ranger wants to know how mixed the **native** plants still are at Site B. Leave out the iceplant and calculate the index for Site B's four native plants only (their new total is 20). Compare it with Site A's index, and explain why a high native-only index does not mean Site B's native plants are doing fine.

Part C: What the data can and cannot tell you

8. A student concludes, 'The data prove that iceplant caused the loss of native plants.' Name **two** other differences between the sites that could also explain the pattern, and describe an experiment the park could run to test whether iceplant is the cause.

9. Site C's total (40 plants) is smaller than the others. Why can richness depend on how many plants you count? How could the team make the comparison fairer next time?

10. The park can pay for iceplant removal at only one site this year. Should it choose Site B or Site C? Make a recommendation that uses at least **two** numbers you calculated, and name one piece of information you would want before deciding.

A small example to copy

Practice with a made-up sample of 10 plants: 6 of species X and 4 of species Y. Proportions: $6 \div 10 = 0.6$ and $4 \div 10 = 0.4$. Squares: $0.6 \times 0.6 = 0.36$ and $0.4 \times 0.4 = 0.16$. Sum: $0.36 + 0.16 = 0.52$. Index: $1 - 0.52 = 0.48$. Check your work two ways: the proportions at a site must add up to 1, and your index must be between 0 and 1. If you get 0 for every site, you forgot to square.

Does adding a species always raise the index?

Suppose one beach morning glory plant sprouts at Site C, so the counts become 2, 0, 2, 0, 1 and 36 (total 41). Predict whether the index goes up or down, then calculate it to check. Next, suppose 40 more iceplant plants were counted at Site B instead. Calculate the new index. Write a rule, in your own words, about what raises a Simpson's index and what lowers it, and explain why counting a new invasive species could raise the index even while the dune gets less healthy.