Who Goes There? Extension Activity
Measuring Biodiversity in Chincoteague Bay
Instructor Notes

Mathematical Topics: Quantitative reasoning, ratios, proportions, sum of a series

Common Core State Standards in Mathematics:
Content Standards:
N-Q.2: Define appropriate quantities for the purpose of descriptive modeling

Mathematical Practices:
MP2: Reason Abstractly and Quantitatively
MP3: Construct viable arguments and critique the reasoning of others
MP4: Model with mathematics

Estimated Time for Completion Extension Activity: One 50-minute class period.

In this extension of the activity, students are asked to calculate Simpson's Diversity Index for the data given. This is a common measure of diversity that takes into account both species richness and an evenness of abundance among the species present. The formula for calculating the index, *D*, is given by:

$$D = \sum_{i=1}^{s} p_i^2$$

Where *s* is the number of species and *p* is the proportion of individuals in the ith species. The value of *D* ranges from 0 to 1. With this index, 0 represents infinite diversity, and 1 represents no diversity. That is the bigger the value of *D*, the lower the diversity.

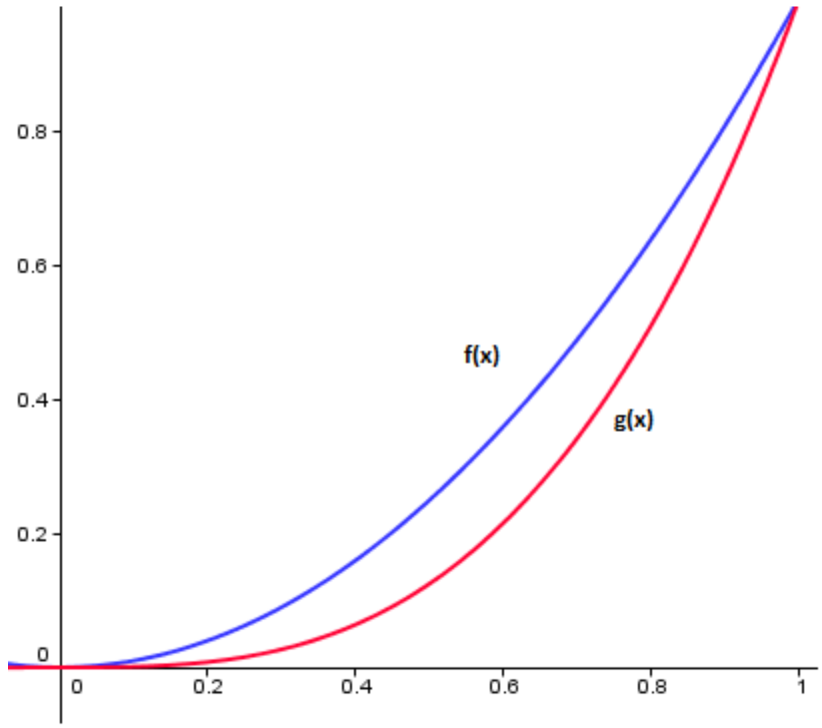
Students are asked to use this formula for the otter trawl data and comment on the biodiversity of the Chincoteague Bay.

Before students calculate Simpson's Diversity Index for the sample from Chincoteague Bay, you may want to help them understand the possible range of values for Simpson's Diversity Index. You could ask them to calculate *D* for some extreme cases. For example:

a. Find the value of *D* for a sample of 100 organisms where all of the organisms are of one species.
b. Find the value of *D* for a sample of 100 organisms for which there are only two species with 50 of each species.
c. Find the value of *D* for a sample of 100 organisms, each of which is a difference species.

After they complete these calculations and discuss their results, then you can ask them to find Simpson's Diversity Index for the sample from Chincoteague Bay. Then they can discuss the biodiversity of the bay represented in this sample.

As students consider the formula for calculating D, they might ask: Why are the values of p squared before summing? You could pose the question: What other choices would we have in creating a formula that takes into account the proportion of the species in the sample? Students might suggest that we simply sum the values of p. This calculation would result in a value of 1 for D for all samples which would **not** give us any information about the biodiversity of the sample. Another suggestion that students might offer is that we cube the values of p before summing.



This suggestion can lead to a good discussion of the behavior of functions. If we consider the two functions $f(x) = x^2$ and $g(x) = x^3$ between the values of 0 and 1. We can see from the graphs shown to the right that the graph of f grows faster than the graph of g for x between 0 and 1. To think about how this affects the value of D, we can consider that we are summing the values of f and then summing the values of g. In both cases the behavior of the functions f and g will affect the sum in a similar fashion. Recall that the lower the value of D, the more diverse the system. In considering the graphs of f and g for values closer to 0, we can see that it is easier to distinguish between the values of f than those of g. You may want to ask students to investigate this numerically. They can compare the differences in values of f and g for consecutive values of x. To do this they can make a table of values considering x between 0 and 1 as shown below:

x	$f(x) = x^2$	$g(x) = x^3$	$\Delta(x^2)$	$\Delta(x^3)$

This extension gives students an opportunity to see a real-world application of the sum of a finite series and a chance to consider how we can use mathematics to measure the biodiversity in a sample population.