This activity is meant as an exercise in critical thinking. Students should have to do research to come up with data, and use writing skills to type this up in a readable document. They should learn about biodiversity, and use their math skills along the way. There is no one correct answer. As long as the student can justify their reasoning and it is sound, they should be awarded full credit. One may want to allow for multiple drafts as students often are not used to writing in a math class. Some instructors may want to grade on more than just completeness of answers.

This activity can be easily modified for any body of water in your area, provided that the information is available.

For those who want to go the probability route, one can contact the Great Lakes Research Center (`http://www.mtu.edu/greatlakes/`) for data or even possibly getting involved in the data-gathering process. Going this route would involve a lot more guidance from the instructor.

More advanced work could be done to calculate a rarefaction curve, then use the following formula to estimate the number of species in the body of water (compare to known data):

$$S_{estimated} = S_{observed} + \frac{a^2}{2b} \tag{1}$$

where S is the number of species, a is the number of species with 1 individual in the sample, b is the number of species with 2 individuals in the sample.

Here are the thoughts I had while designing this, and which will be fleshed out in later iterations:

The Great Lakes (Huron, Ontario, Michigan, Erie, Superior) are the largest freshwater system of lakes in the world. Altogether they account for 21% of the world's freshwater lakes. Do they also hold 21% of the world's diversity? How can we determine this?

First, what is biodiversity? How do we measure it? Do we look at plants only? Animals only? Of the animals, do we look at only fish?

And how do we focus on Lake Superior? Do we divide the 21% by 5 (the number of great lakes) or do we figure it out proportionally?

First, let's define biodiversity.

Biodiversity is roughly the number of species in a specific area. More specifically, it stands for "biological diversity."

> Biological diversity, or the shorter "biodiversity," (bio-di-ver-si-ty) simply means the diversity, or variety, of plants and animals and other living things in a particular area or region. For instance, the species that inhabit Los Angeles are different from those in San Francisco, and desert plants and animals have different characteristics and needs than those in the mountains, even though some of the same species can be found in all of those areas.
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> Biodiversity also means the number, or abundance of different species living within a particular region. Scientists sometimes refer to the biodiversity of an ecosystem, a natural area made up of a community of plants, animals, and other living things in a particular physical and chemical environment.- `http://biodiversity.ca.gov/Biodiversity/biodiv_definition.html`

Mathematically, the easiest way to measure biodiversity is to count the number of species. For our purposes, let's look at the biodiversity of fish species.

Lake Superior has 34 native fish species, 17 non-native fish species, and 2 non-native non-reproducing fish species (`www.seagrant.umn.edu/superior/facts`). Current estimates for the total number of fish species is 32,000 (International Union for the Conservation of Nature, IUCN 2011). If we assume that the fish species

are distributed equally across all bodies of water, how many do we expect in salt water, and how many in fresh water?

0.008% of the world's water is freshwater that holds fish (`water.usgs.gov/edu/earthhowmuch.html`). The total amount of water in the world is 332.5 million cubic miles (`water.usgs.gov/edu/earthhowmuch.html`). That is 332.5×10^6, or 332,500,000 mi^3.

So that means 26,600 mi^3 freshwater, and 5,586 mi^3 is in the great lakes.

Lake Superior has a volume of 2,900 mi^3 (`www.seagrant.umn.edu/superior/facts`). Thus 0.00087218% of the TOTAL water in the world is in Lake Superior, and 10.9% of the freshwater that holds fish is in Lake Superior.

Not all water in the world holds fish. Do we need to find out how many freshwater fish we have? Then we can find what percent of the freshwater is in Lake Superior.

Current estimates are that there are over 15,000 species of freshwater fish (`www.iucnffsg.org/freshwater-fishes/freshwater-fish-diversity/`). This means that we should expect 1,635 species to be in Lake Superior. How does this compare to what we know? There are only 53 species in actuality. Why is this?

By comparison, we expect 3150 species in the Great Lakes but there are actually just over 170. Does this mean we did our calculations wrong? If not, what can this tell us?

Additionally, Lake Superior only holds 31.18% of of the species of the Great Lakes, yet it holds just over 51% of the water. Ideas?

This activity is in the beginning stages. First run of the activity will occur late June, followed by an evaluation of the effectiveness and improvements. A second run will be done mid-October.

Please contact Stephanie Kajpust at `stephanie.kajpust@gmail.com` for any suggestions or comments.