Exploring the distributions of species in mixed/short grass prairies in Pleistocene and Holocene North America

Premise: North American ecosystems have fundamentally changed over the late Pleistocene and Holocene; from a system dominated by mammoths, to bison, to domestic livestock. Given the very different body size and herd formation of these 'ecosystem engineers', it is likely that animals influence soil structure, water tables, vegetation and other animals in the ecosystems. What has been the ecological influence of the continued 'downsizing' of the largest animals in the ecosystem?

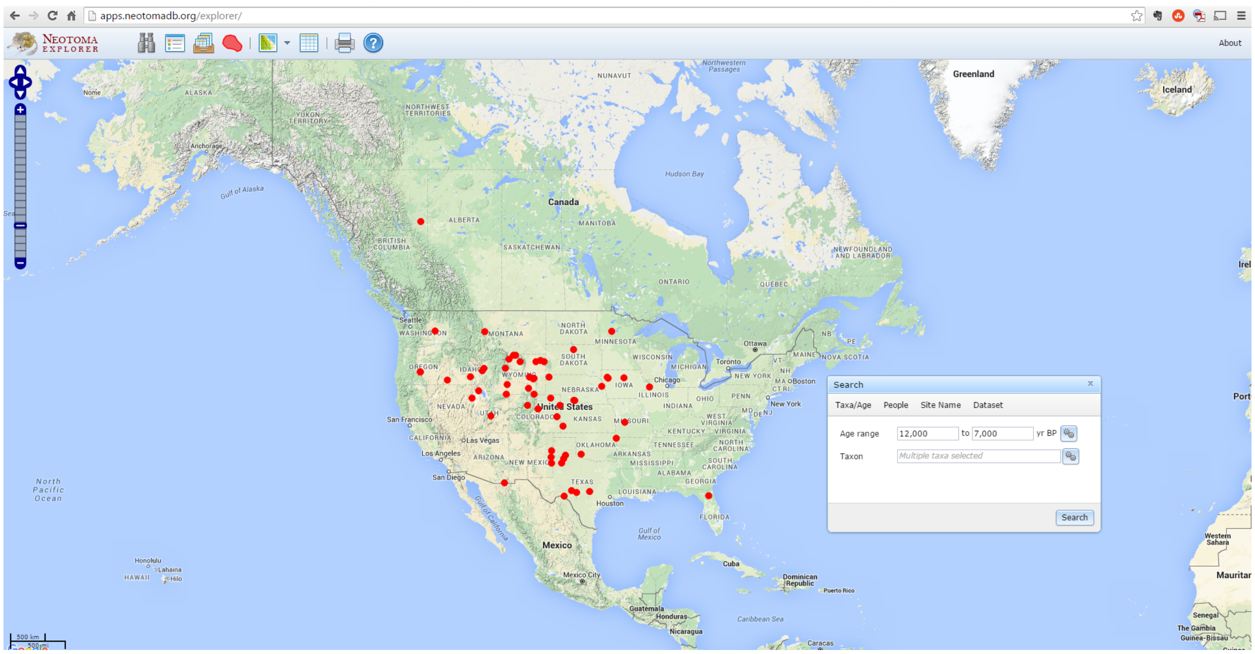
Learning Goals:

1. Students will understand
    a. that ecosystems are dynamic and change is continual.
    b. significant patterns in and impacts of climate change during the late Pleistocene and Holocene in North America.
    c. how climate change, human action, and alterations in species distribution have collectively influenced the distribution and abundance of grassland ecosystems in North America.
2. Students will be able to use the Neotoma database and ArcGIS to investigate the role that "ecosystem engineers" play in driving ecosystem change. In particular, they will be able to generate distribution maps and compute the overlap of geographic ranges among multiple taxa.
3. Students will develop hypotheses about the role played by top consumers in shaping observed variations over time in grassland ecosystems.
4. Students will think critically about the possibilities and limitations of using a multi-proxy database such as Neotoma to investigate questions about climate change, ecology, and human action in North America.

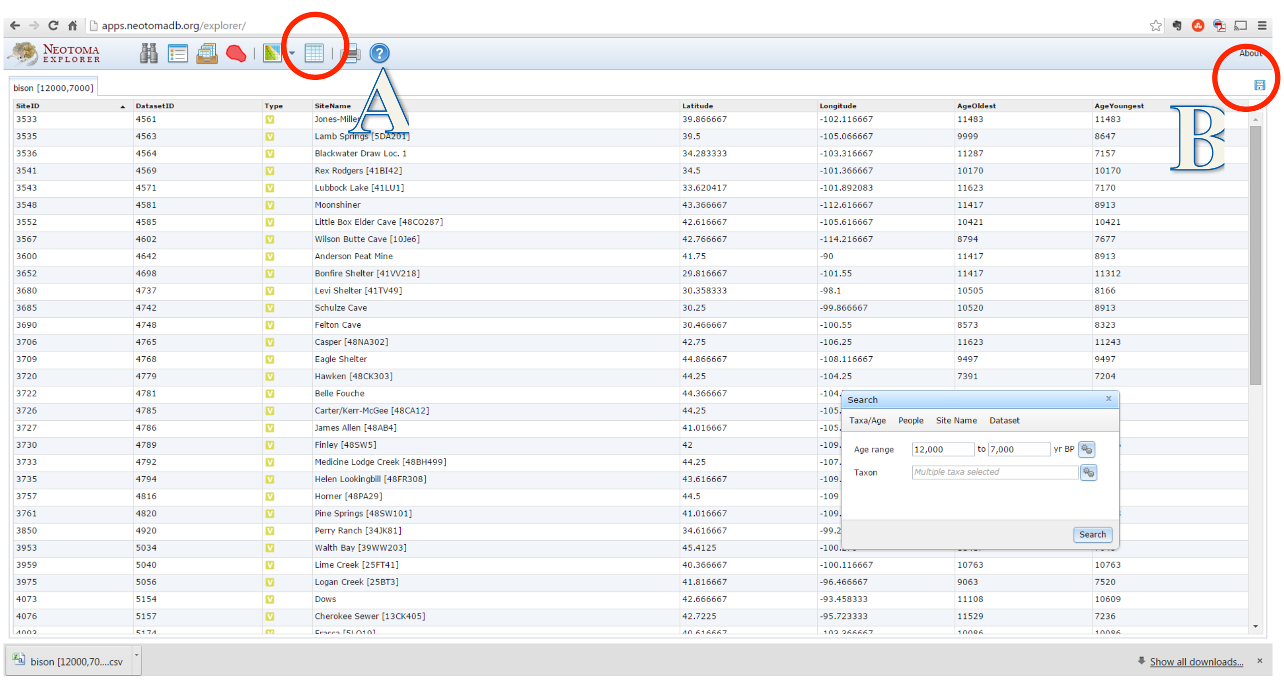
Exploring the distributions of species in mixed/short grass prairies in Pleistocene and Holocene North America using co-occurrence patterns & ArcGIS analysis of overlap

The Neotoma Paleoecology Database interfaces well with the free ArcGIS Online tool that allows for easy geospatial analysis.

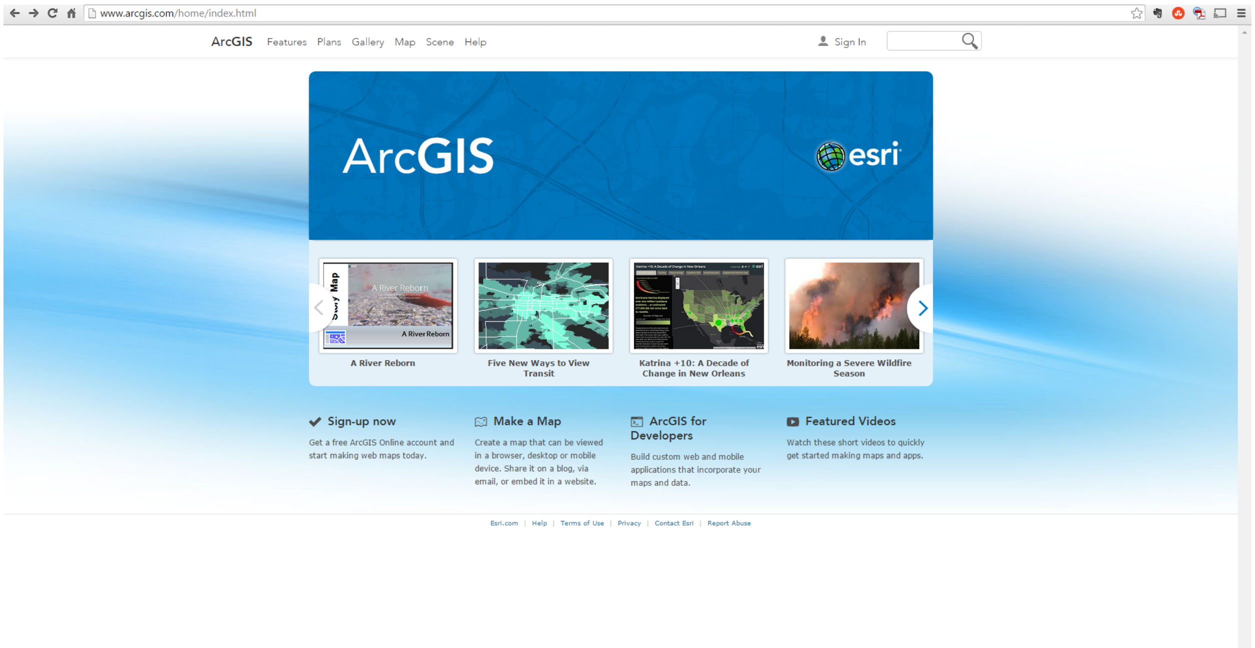
1. To start, in Neotoma search for the data that interests you. Below are the search results for records of *Bison* from 12,000 to 7,000 BP.



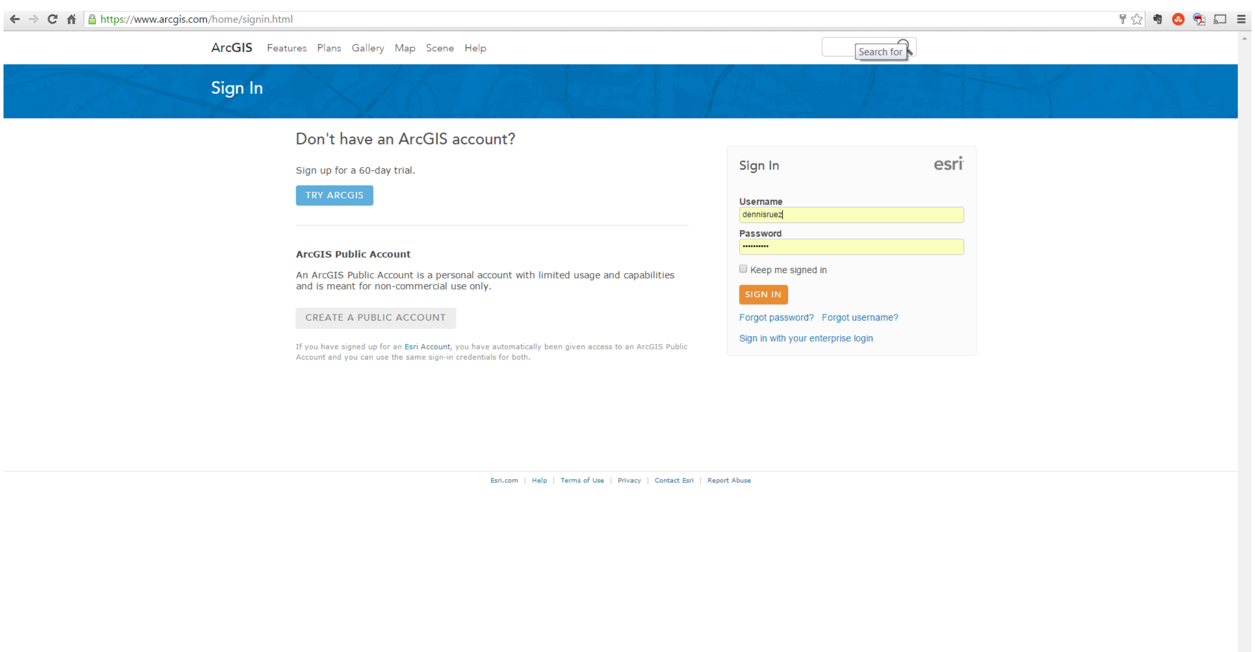
2. Choose the View Search Results in Table icon (A in figure below), and download the data in a csv file (B).



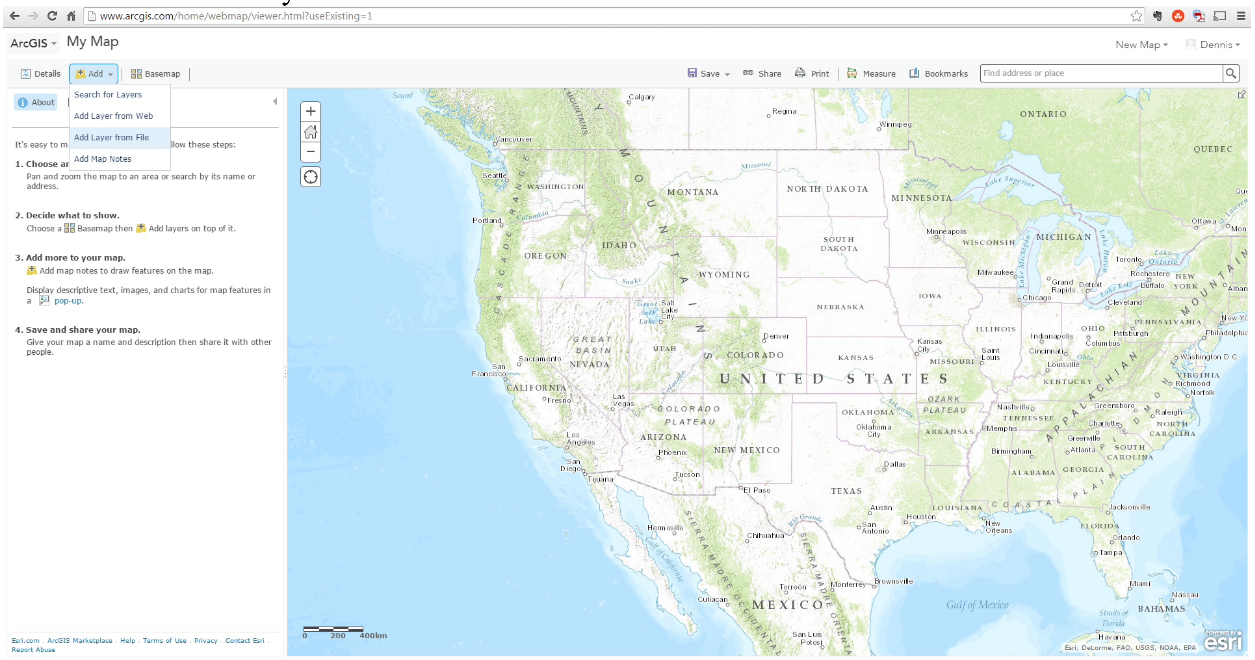
3. Visit www.arcgis.com, choose Sign In.



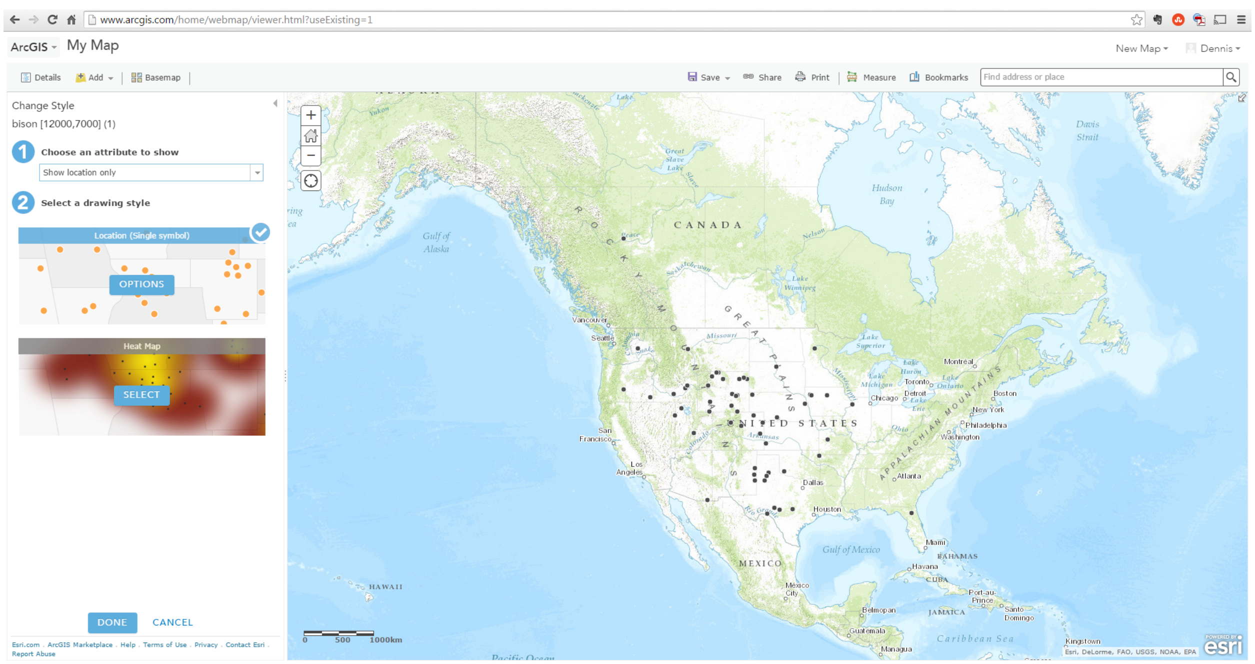
Sign in if you have an account. If you don't already have an account, create a free public account.



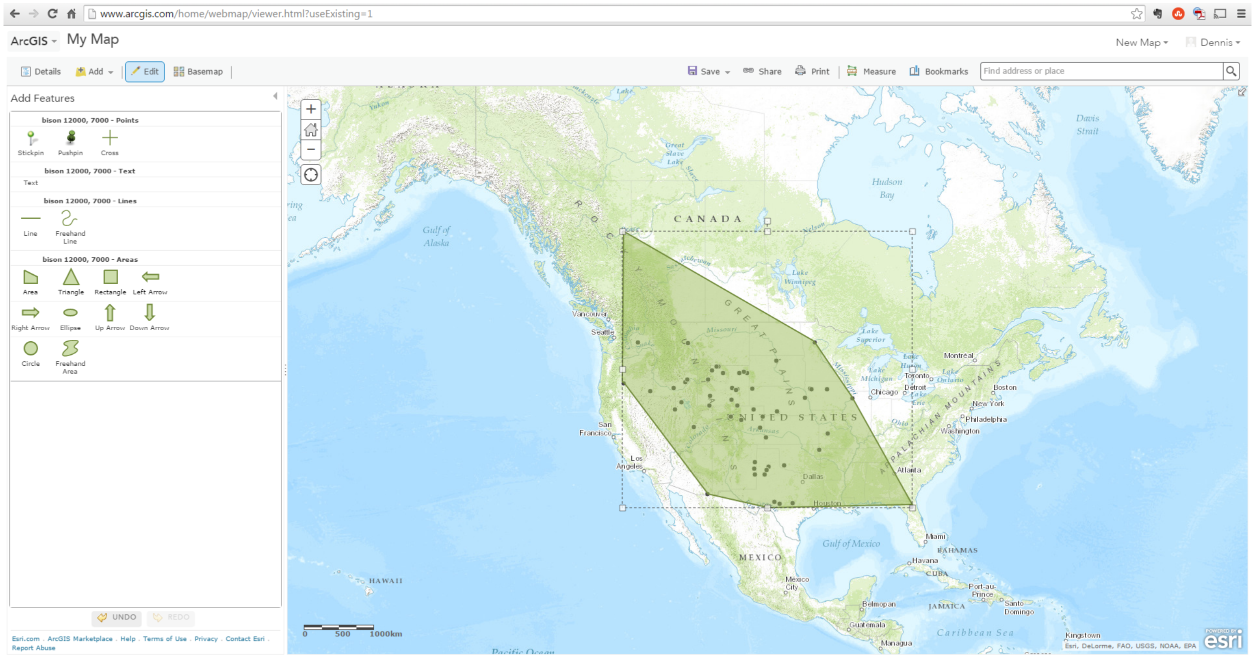
5. Once you've signed in, in the upper left corner, choose Add which will open a dropdown menu. Select Add Layer from File.



6. Choose the csv file you saved from Neotoma, and click to import. The data will now be plotted on the map.



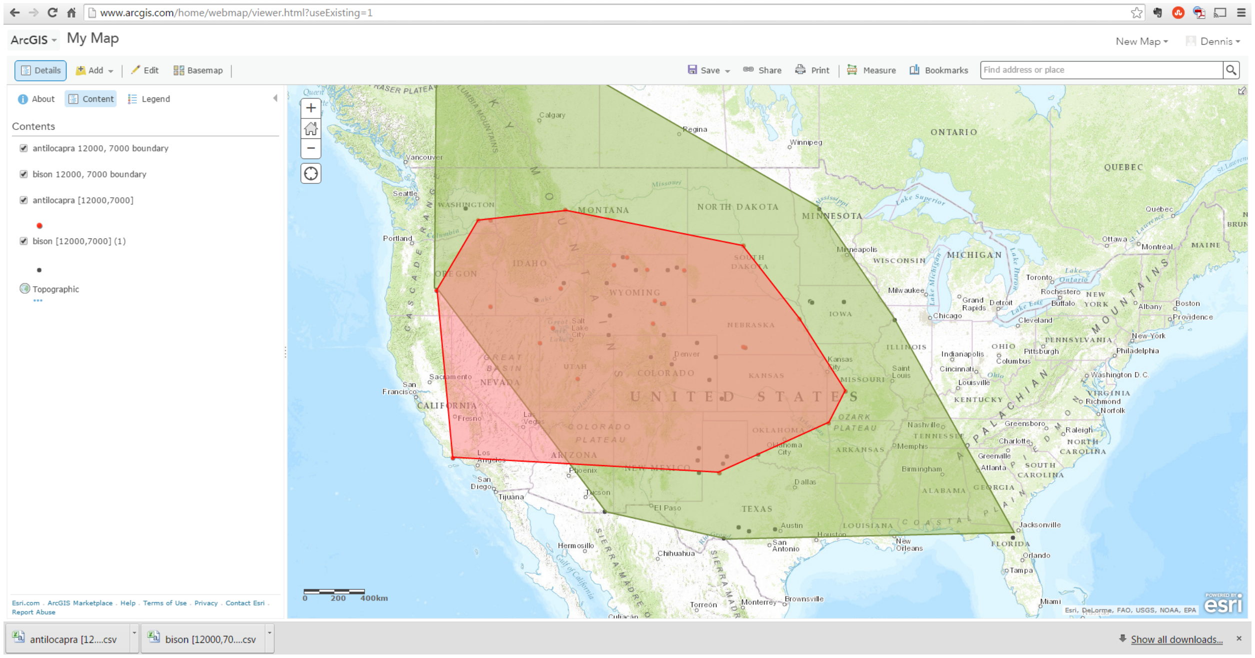
Along the left side you will have options to change the plot style. For (1) choose Show Locality Only. The Heat Map shows where the higher densities of deposits occur, but obscures the details of the distribution. Choose Location (Single Symbol). Select Options, then Symbols, and chose the shape, color, and symbol size that you prefer. Click OK, then Done, then from the Add menu choose Add Map Notes. Keep the template as Map Notes, and name the item the same as the data you are mapping. Choose the Area feature in the Area category on the left bar. You now want to click the outermost sites until you have encircled all – double-clicking on the last point that closes the loop.



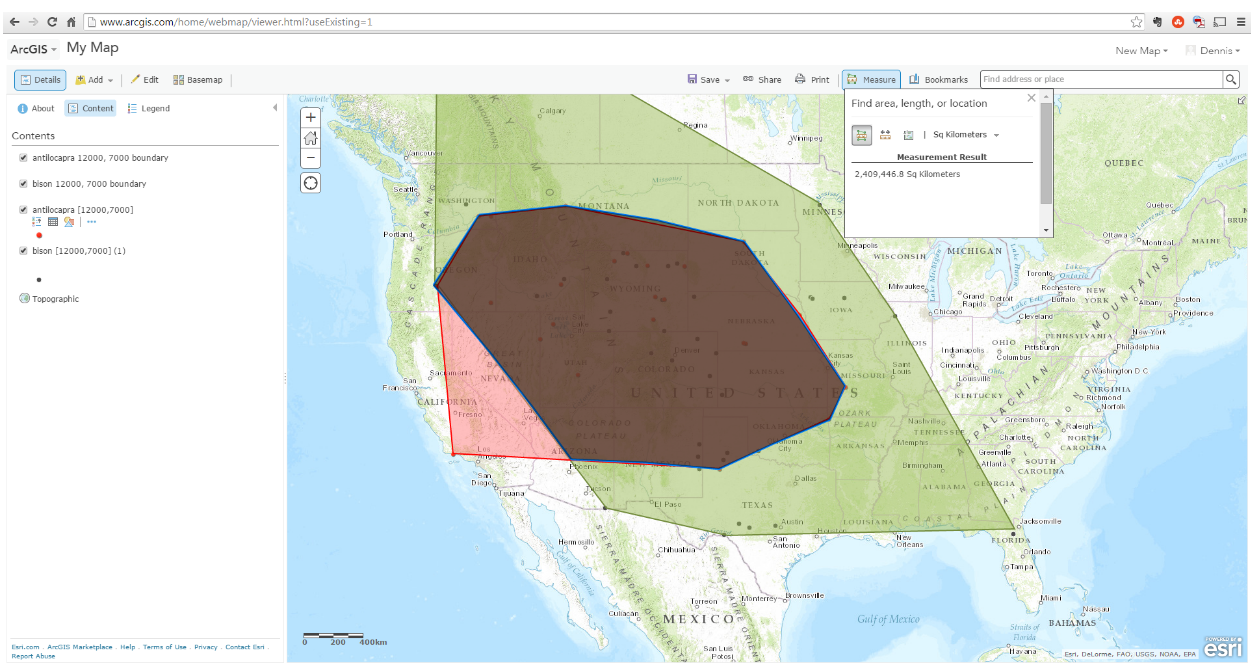
7. Click on Edit, and you can name, describe, and format text regarding your polygon. Choose Change Symbol to edit the edge and fil colors. For clarity, it's best to match the color of the polygon to the sites.

8. Repeat the above steps for other layers to see the interplay of multiple layers. Use different colors for each group of data.

9.Using the Details button at the upper left, you can check/uncheck buttons to show/hide various layers. The next image shows the combination of *Bison* and *Antilocapra* (pronghorn) from 12000 to 7000 BP.



10. Show the layers you want to view for overlap analysis, select Measure at the top and select Area. Click on one of the corners of the overlap corners, scroll to the next and click. Continue until you double click on the last point. Even if you are very accurate in your selection of points, you might notice that some lines on species boundary lines and your area measured boundary don't match exactly. That's an artifact of the software that shows the map notes as flat images (non geographic data), but uses the true straight-line distance with the Measure tool. The area of overlap will be shown in the dropdown box. (Note: the polygon you drew to measure the overlap is temporary and will disappear. If you want to save it, instead use the Add Map Notes feature – understanding that there is a slight difference as just mentioned.)



The above example shows the overlap between *Bison* and *Antilocapra* for a 5,000 year interval from 12,000 to 7,000. Explore other intervals, especially 7,000 to 4,000 BP and 4,000 to 500 BP.

11. Explore other combinations of animals and plants, particularly with the changing dominant grazer (mammoth or bison). (In other words, do an internet search for other plants and animals that you would expect in a short or mixed grass prairie.) If you choose to compare to *Bison*, use the time intervals listed above. This will allow you to examine environmental change after the late Pleistocene megafaunal extinction. If you choose to compare to mammoth (*Mammuthus*), use 30,000 to 20,000 BP, 20,000 to 15,000 BP, and 15,000 to 10,000 BP. (Mainland mammoths go extinct before 10,000 years ago, but selecting this will capture samples with older radiometric dates that have larger error ranges.)

1. For the pair of species you chose, how has the measured area of overlap changed over time?
2. How has the overlap, as a percentage of the area of distribution of the smaller range, changed over time?
3. Hypothesize what is driving the change, or lack of change, of the overlap of distributions. Climate certainly affects where plants and animals occur, but think of other potential impacts as well.
4. Scientists always want more data. Other than that, what might be some potential problems with this approach to examine changes in plant and animal distributions?