GEO 423/EVS 523
Exercise 13: Friction and Cost Distance Analysis

The notion of distance is surprisingly complicated. We commonly think in terms of Euclidian distance, or straight-line distance. Obviously the distance from point A to point B is easy to calculate, isn't it? Take the difference in easting, square it, take the difference in northing, square it, add the two squares, and take the square root. Done. Good old Pythagoras!

Well, not quite. Straight-line distances don't always reflect the distances perceived by phenomena in the real world. In this exercise you will consider the obstacles to moving from one place to another and associate a cost of movement to the actual transition from one pixel to the next. In so doing, you will calculate something known as cost distance, which in many ways is a better means of describing the distances perceived by real-world phenomena.

1. Your first step is to take a county and find its land-use-land-cover map. In principle, you can take any county you wish, but it is probably easiest if you take Cuyahoga County. Copy the CuyahogaLULC directory from the P: drive to your X: drive. It contains two files. The first is an Arc Interchange (e00) file that will give you land use for 1994; the other is a raster file showing land use for 2003. Be sure that you have the Spatial Analyst extension turned on.

2. You should open both images. Note that one is a raster; the other is a polygon. You can open the raster directly. You will need to use the Coverage Tools -> Conversion -> To Coverage -> Import from Interchange File to open the polygon file. You will then have to use the Conversion Tools -> To Raster -> Feature to Raster to convert the polygon to a raster file. Make sure that you use the Grid_Code as the value for the raster and make your raster cell size the same as in the Imagine file. You should probably make your output cell name something like **lulc94.img**. Adding the **.img** to the name will insure that it is an ERDAS Imagine file. For this exercise, this is desirable.

3. With both land-cover images in your viewer, examine the detail in each. Which do you think better describes the nature of land cover in the area of and around Cuyahoga County? Pick the image you think is the more accurate rendition of land cover. If you want to make a composite of both images, you can do so using the raster calculator.

4. Now pick an animal or plant. It can be somewhat fantastic (e.g. a unicorn or yourself), or it can be real (e.g. deer or salamanders). Make a table showing what you would expect the impedance to travel would be for your organism in moving across each land-cover class. One way of looking at this would be to guesstimate how long it would take for your organism to move from one side of a pixel to the other for each land-cover class. The longer it takes, the higher the impedance. It doesn't make a great deal of difference in practice what units you use; however, the relative values of the impedances should be as reasonable as you can make them. You will probably want to be creative in this part of the exercise. In principle, there are right answers, but you don't know what they are, so don't worry about that. Try to come up with reasonable relative values. Remember that your friction values reflect the difficulty (i.e. the friction) of crossing a pixel. Impassible pixels should get very high values (e.g. 1000); pixels that would be attractive to somebody trying to cross it should get very low values (e.g. 1). You might want to try to look at the land cover from the perspective of some organism (e.g. a deer or a coyote or a salamander) and choose accordingly. You might want to consider several different organisms and develop a couple of friction layers.

5. You will next create a friction surface from your LULC image. Go to Spatial Analyst Tools -> Reclass -> Reclassify. Your input raster is the LULC image; the output image is the friction image. Click the "Unique" button to insure that you will enter a friction value for each land-cover type. Assign the friction value that you have determined for each type of land cover.

4. You will now create two scenarios. In one, your organism will move from one place to another. In the other, it will reproduce and gradually spread out over several generations from the original center of its

distribution to the remainder of the county. You must first establish a center of distribution. To do this, right-click on the X: drive in the catalog window and choose New -> Shapefile. Give it a name. Make sure it is of type Point, and give it the same reference system as your land-cover image. Use the Editor toolbar to Start Editing, then choose your point file as a template, then put a single point in the Cuyahoga Valley National Park (or other suitable point of origin). Do the same to create a point file containing a single point for your destination file. The new files should have been added automatically to your layout; if they weren't, add them.

5. Click on Spatial Analyst Tools -> Distance -> Cost Allocation. Your input source is your Origin point shapefile; your cost raster is your friction image. Give names to all of the other output rasters. You probably won't use the Cost Allocation file (although you have to give it a name), but you will use the Cost Distance and Backlink rasters, even though they are optional. It will take a while for the computer to crank through all of these files, but it will work!

5. When your Cost Distance and Backlink files are complete, take a look at them. You will very likely have to change the color scheme (use classify) for the Cost Distance file, as you may get some very strange patterns, based on the friction value you placed on background. You will probably want to change the number of classes to 32 and choose a quantile distribution of colors. You should probably have even more problems interpreting the Backlink file. Look at its description and don't worry about how weird it is. The Cost Distance file is the solution to one of the scenarios posited above: the length of time it would take for your organism to reproduce and gradually spread out over several generations from the original center of its distribution to the remainder of the county.

6. You are now ready to find the least-cost path from your BeginPoint to your EndPoint. Click on Spatial Analyst Tools -> Distance -> Cost Path. Your Feature Destination point is your EndPoint shapefile; your Cost Distance and Backlink rasters are the files you created in step 5. Give your output file a name and click OK. Does your path make sense? How different is it from a straight line?

Portfolio

13-1 A map showing the unprocessed land-cover image you used for your analysis

13-2 A map showing the friction layer and the points of origin and destination considered in your least-cost pathway

13-3 A map showing the cost distance in your map from the point of origin

13-4 A map showing the least-cost pathway from the point of origin to the point of destination