Engineering Applications of GIS - Laboratory Exercises

Civil and Environmental Engineering

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Laboratory Exercise - NFL Team Placement

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Background

GIS is used by corporations and groups internationally to manage aspects of their business such as shipping, inventory, sales, marketing, facilities, and expansion plans. When dealing with expansion in particular, GIS is used to determine the most appropriate placement of a new store or location.

This laboratory exercise assumes that the National Football League is interested in creating a new team. This new team will be placed in the continental US. For the analysis that you will do, a number of data layers will be required, weather found at the references online sources or created manually. Once the data layers are acquired, one must then conduct spatial analysis using GIS overlay tools to identify the most suitable locations for the new team. For purposes of this activity, ArcGIS 10.3 ArcMap will be used. A resulting map will be generated showing the most appropriate locations, given the criteria specified, for the additional of a team.

Problem Statement

There are currently 32 total teams in the National Football League. Each team brings is somewhere between 320 and 840 million US dollars in revenue each year. These teams bring a sense of pride and loyalty to the members of the community that houses them. The NFL brings entertainment to many Americans and is seen as a representation of American culture. The goal of the NFL is to provide the highest quality entertainment to their audience, clearly profitability is a key factor is determining if a team is viable.

Presume that you have been hired to consult the NFL as to where to place new teams. As you can imagine, there are specific factors that will determine the success of an NFL team. You will only be expected to provide recommendations on a city level, not by a specific address or plot of land that you think should house a stadium. Suitable areas can be determined by creating layers based on limiting criteria and then combining those layers to find the places that meet all of the criteria. For this project, you are tasked with identifying the most suitable cities in the nation for placement of new NFL teams.

Spatial Considerations

For the purposes of this exercise, you will arbitrarily limit the factors with which you are concerned to the following:

- Proximity to existing NFL teams: You are to find location that are at least 50 miles from any current teams. Apart from the meeting this 50 mile criteria, you should consider locations that have a low density of other teams, meaning that there not only is there not another team within 50 miles, but that the closest teams are farther away than other locations.
- Population Density: Optimally, the new teams will be located in a densely populated area.
- Expendable income: NFL teams are most feasible where the population has some money to spend on tickets, apparel and other products related to the team. It is also important to locate teams near major business areas where corporations will be likely to buy ad space at games, the presence of such corporations in an area can usually be correlated with the median income of the population.

Data

The following datasets will be needed for this project. You can either download the data from the suggested sources or create the data you need to complete this exercise.

- http://sedac.ciesin.columbia.edu/data/set/usgrid-summary-file1-2010 NASA Socioeconomic data files. You can find a shape file by going to the data download tab and following the download wizard. It will allow you to produce a shape file containing all the counties in the US with associated attributes that you will need.
- Current NFL team locations: You will need to create a point file containing points where each of the current NFL teams are located. It isn't necessary to be extremely precise, remember that you will be placing a 100-mile buffer around each team. Search online for a list of current NFL teams and create the data file accordingly. Name the point file NFL_Stadiums.
- https://deadspin.com/heres-facebooks-2014-nfl-fandom-map-1631006587 As a reference to compare with your results, follow this link to a fan base map that was created using data pulled from social media sources.

ModelBuilder Tools

You will be using the ModelBuilder tool that is introduced in the Basic Skills chapter of this book. The following is a list of tools that will be used in the example model and their purpose in the lab assignment. For more information on how to use any of these tools, use the tool help service in ArcMap or search the tool online.

- The Polygon to Raster tool is a conversion tool that takes a single attribute from our county shape file (in the form of polygons) and converts it to raster data that can then be used in the model. This tool is used several times.
- The Reclassify tool changes values in a raster. In this exercise, you will use the reclassify tool multiple times.
- The Buffer tool is a proximity operation which creates an area of equal distance, specifies by the user, from, a feature. In this case the feature to be buffered around will be current NFL teams.
- The Kernel Density tool creates a smooth surface from points or polyline features using a kernel function.
- The Plus tool takes two raster data sets and adds them together.

Example Model

NFL Team Placement
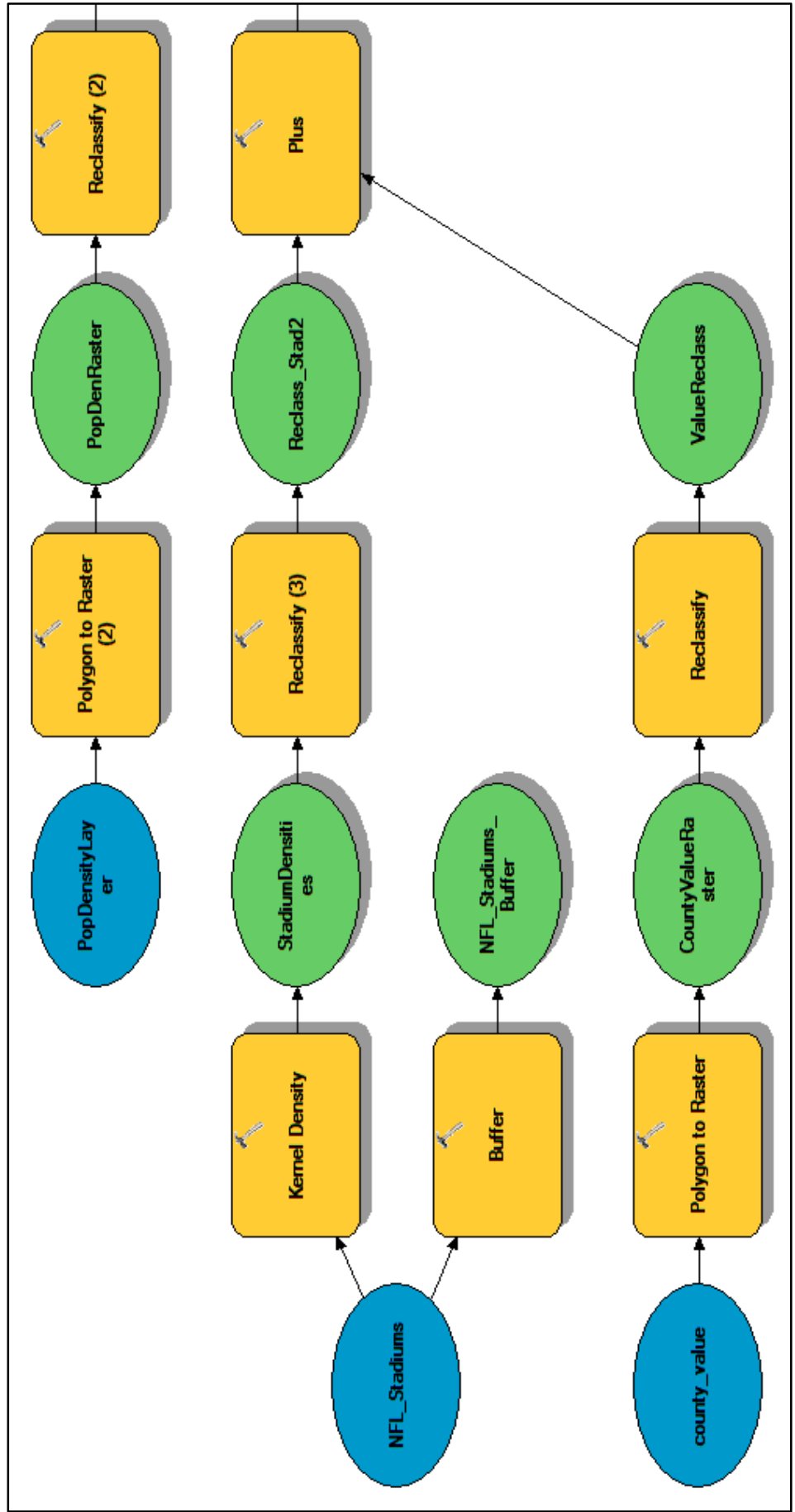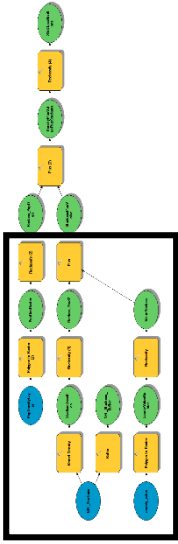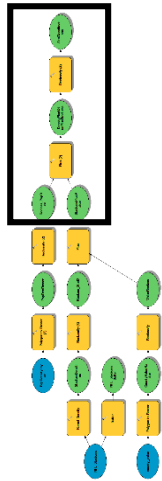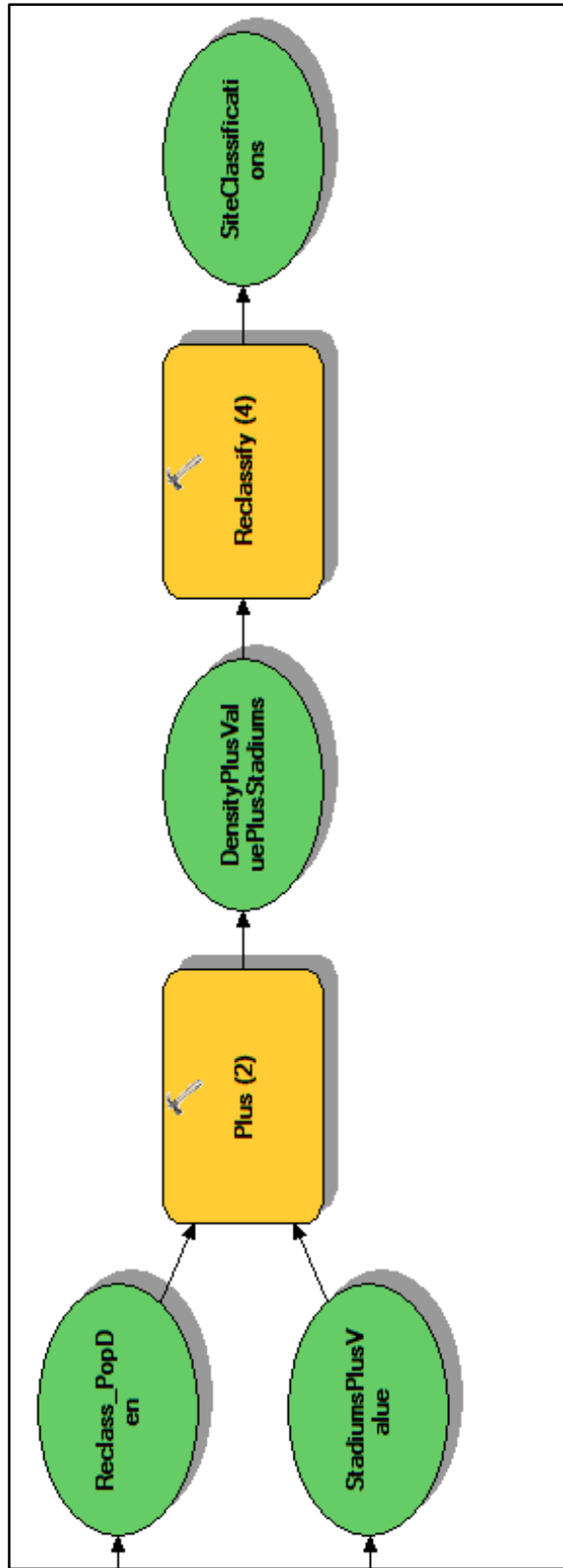
Example Model

Step by Step Solution

For an advanced GIS student, the information up to this point is all you need to complete the assignment and create an output map from the4 results. Feel free to try conducting the analysis using only the information provided above. If you need specific steps, follow the following instructions.

Step 1

Before beginning in Model Builder, take the shape file layer you downloaded from NASA and create two separate inputs with this data. To do this, select the layer by right clicking your county file and select "Properties…". Inside the Properties box select the Display tab. In the Display tab select the dropdown down labeled "Field" in the "Display Expression" area as seen below. Select the MEDIAN_VAL field to display. Then name this layer county_value.
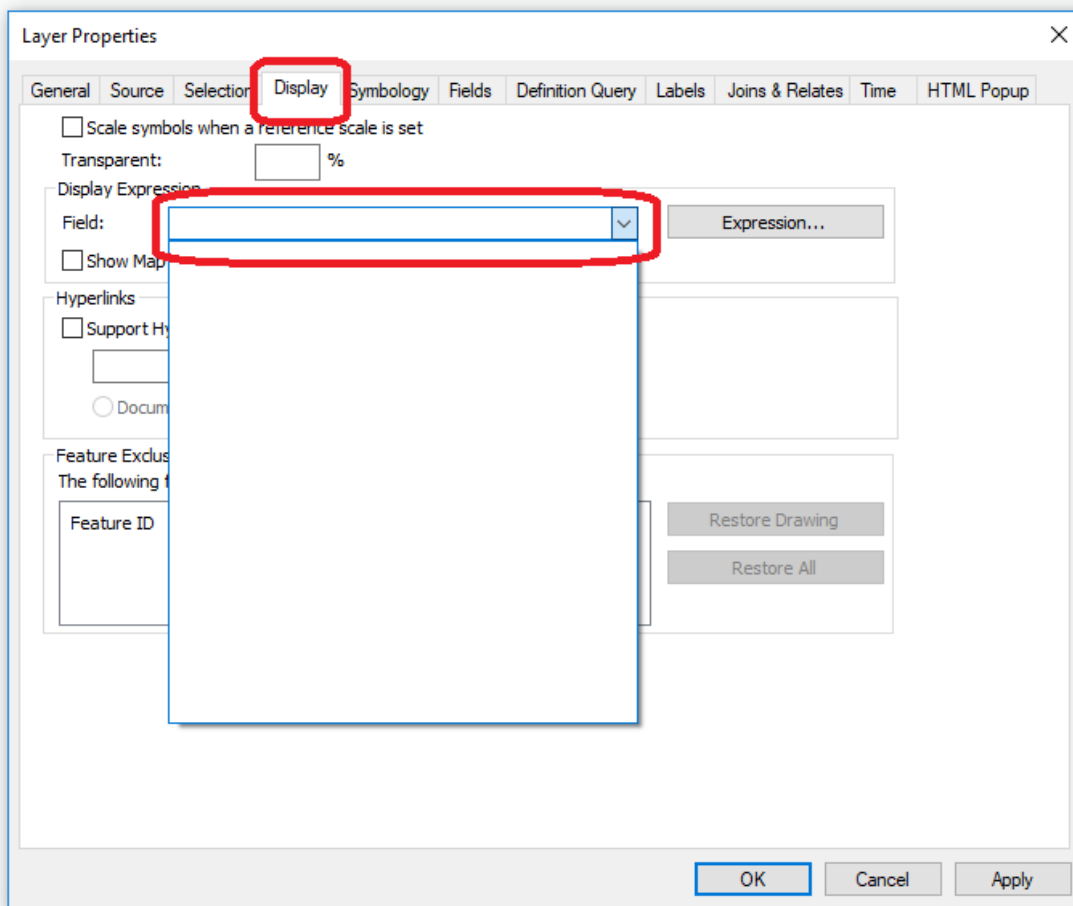

Copy your shape file into ArcMap again and repeat these steps but this time in the drop down selection choose the POP90_SQMI value field and rename this layer PopDensityLayer. Now you have two separate inputs for your NASA data.

Now we can begin Model Builder. Using the "Polygon to Raster" tool we can take our county_value input and turn it into raster data. In the "Polygon to Raster" we will make our "county_value" the input feature and the "MEDIAN_VAL" our value field. This will make our wealth by county a raster.
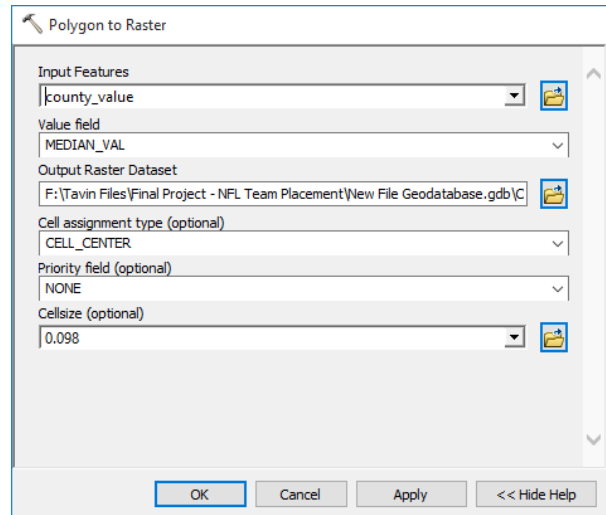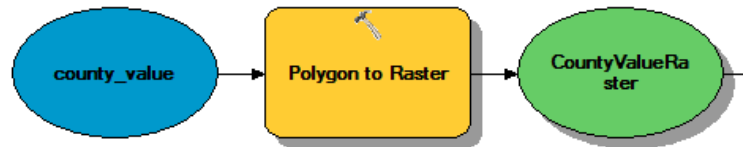

Step 2

Once we have made our county wealth into a raster, we will now reclassify its values with the "Reclassify" tool. Make sure the values reclassified match the values in the dialog box below. If not, change the values to match. Create a new value of 9 for anything with an old value of over 176200. This gives us new values for our wealth distribution that places wealth of counties into classes with 1 being the poorest and 9 being the wealthiest.
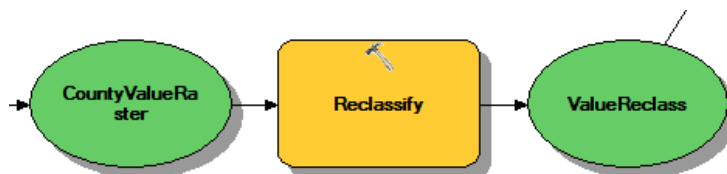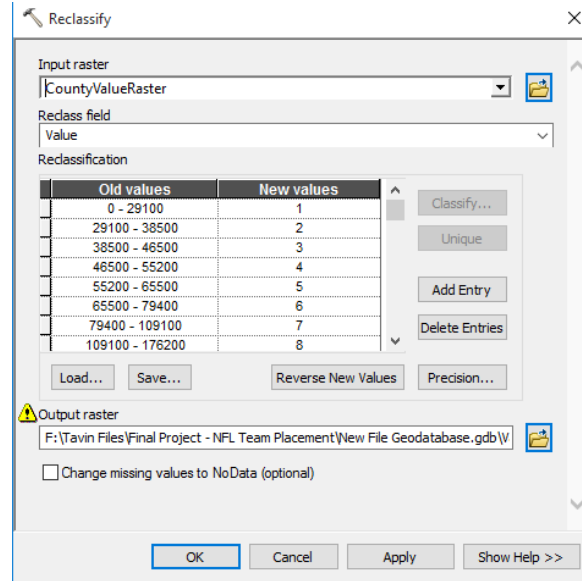
Step 3

Next we will Buffer the point file we created for the existing 32 stadiums. Use the "Buffer" tool to create a 100-mile ROUND buffer around the stadiums. This will simply be used as a visual at the end to compare our results.
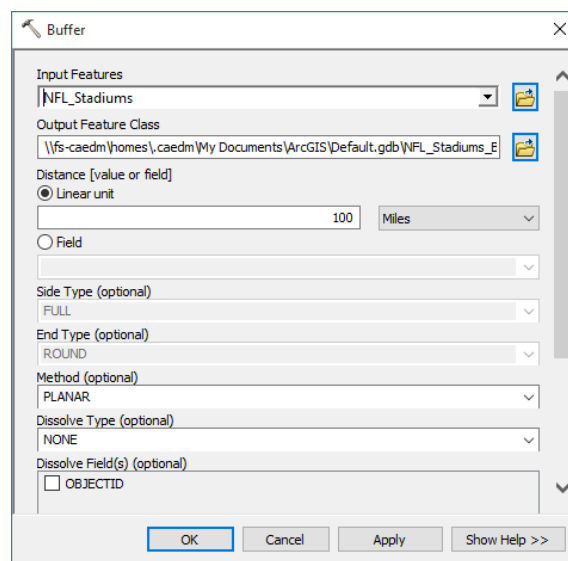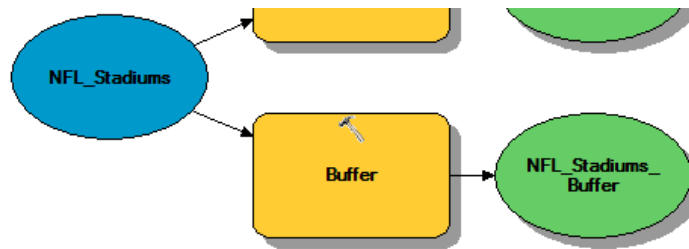

Step 4

With the same stadium point file, use the "Kernel Density" tool in order to create a raster heat map of stadium densities within each county the USA. In the "Kernel Density" box, choose "NFL_Stadiums" as your input and choose 10,000 as the output cell size and 1,000,000 as the search radius. This should create a density raster showing which counties display higher densities. Your dialog box should look like the example below.
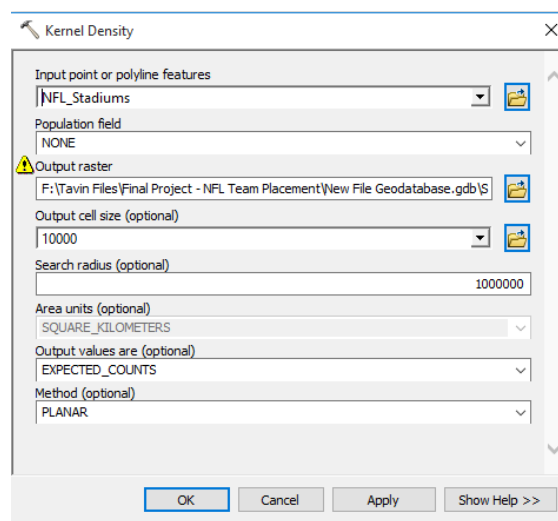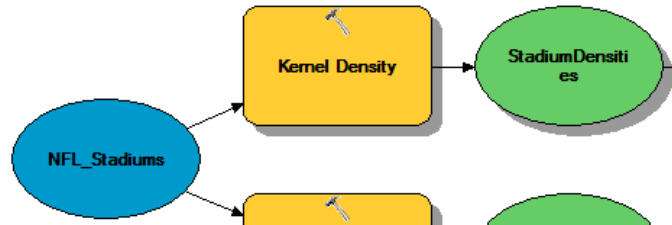

Step 5

Now that we have our "StadiumDensities" we also need to create new classes for these values that will make sense in our results. Once again using the "Reclassify" tool, we will assign new values as seen in the dialog box below. Lower density areas are assigned higher new values because less dense areas will be more desirable for new stadiums with new fan bases.
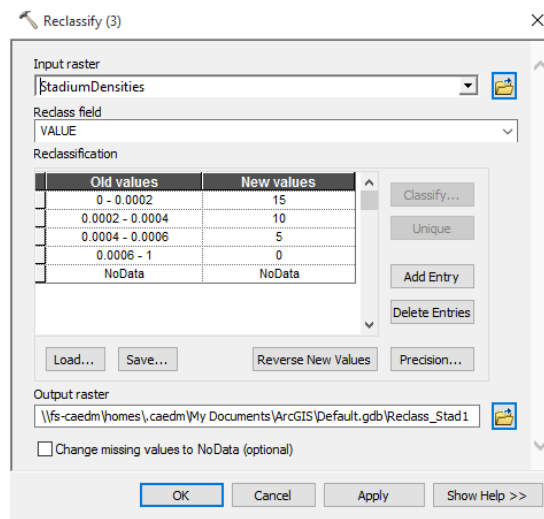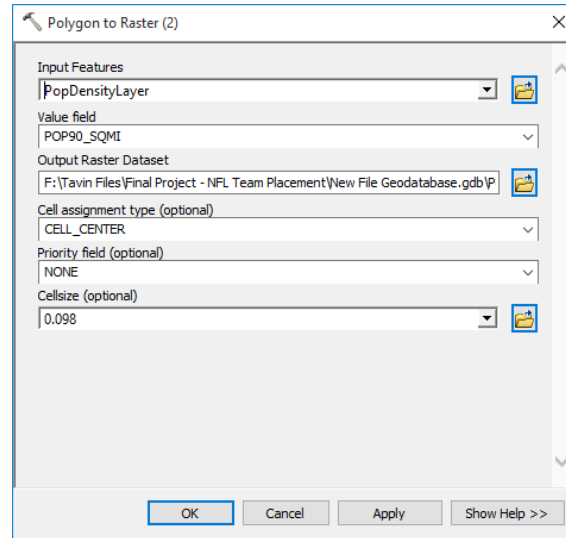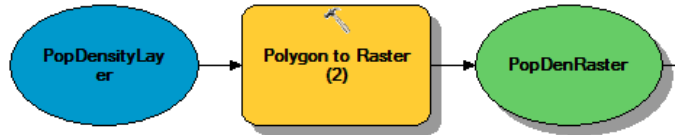
Step 6

Using the "Plus" tool we will add both of our reclassified values for stadium density and county values to create a single value named "StadiumsPlusValue".
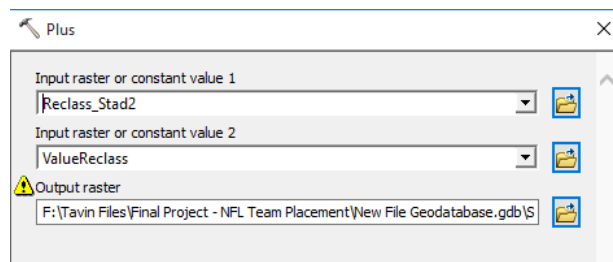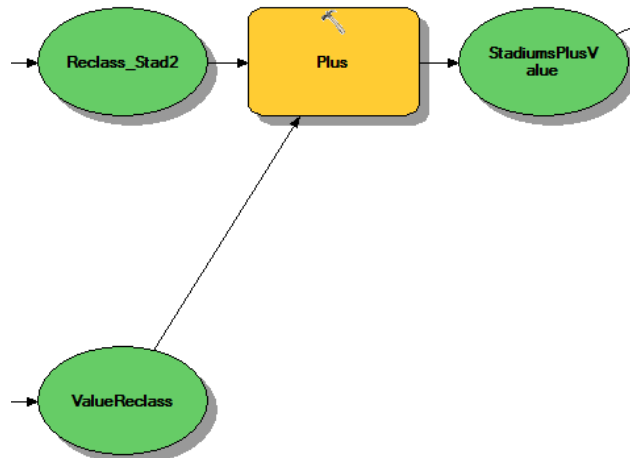

Step 7

Now we will take our final input which is our "PopDensityLayer" and convert that into raster data like we did with the "county_value" input earlier. The value field is "POP90_SQMI".

Step 8

Using the "Reclassify" tool reclassify our PopDenRaster values as seen below. New Value 9 will have a range of 1201-1600 and new value of 10 will be any old value over 1600. We now have new classes with 1 being the least densely populated counties and 10 being the absolutely densest county populations.
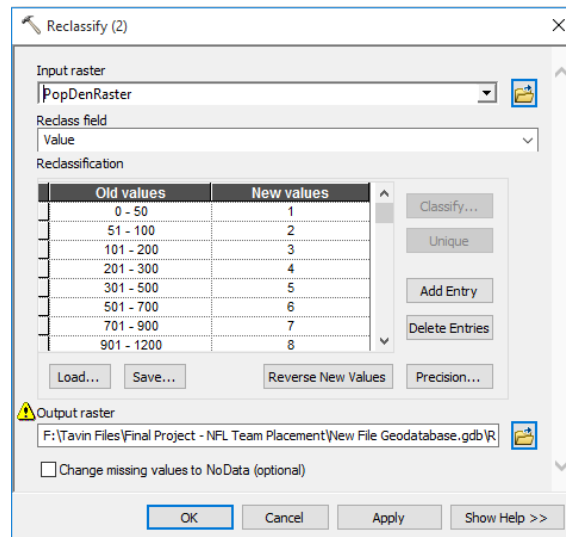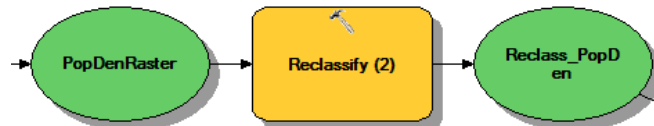
Step 9

We once again will utilize the "Plus" tool to add our reclassified PopDen values to our "StadiumsPlusValues". This gives us one final set of numbers that has added all three of our inputs that are being analyzed.
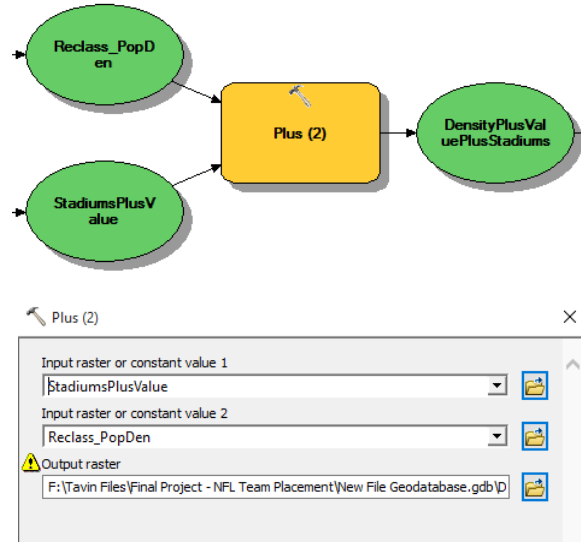
Step 10

Next, you will put a final reclassification on these numbers to classify the desirability of placing a future stadium at the given sites. These values are shown below. Run your model and place your output in your nap. Rename the new values as follows.

1 = Poor Location   2 = Not Ideal   3 = Great Locations   4 = Ideal Locations
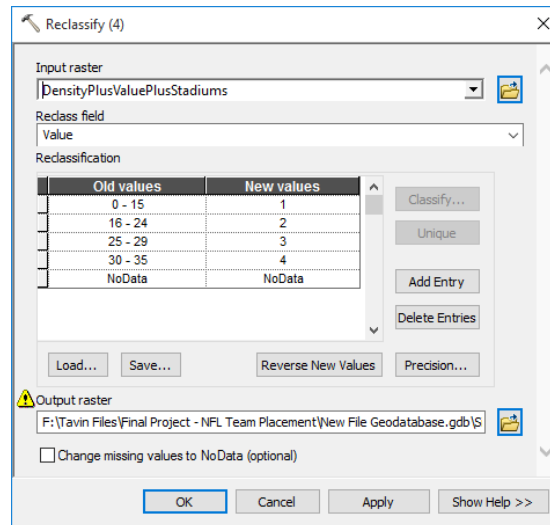
Deliverables

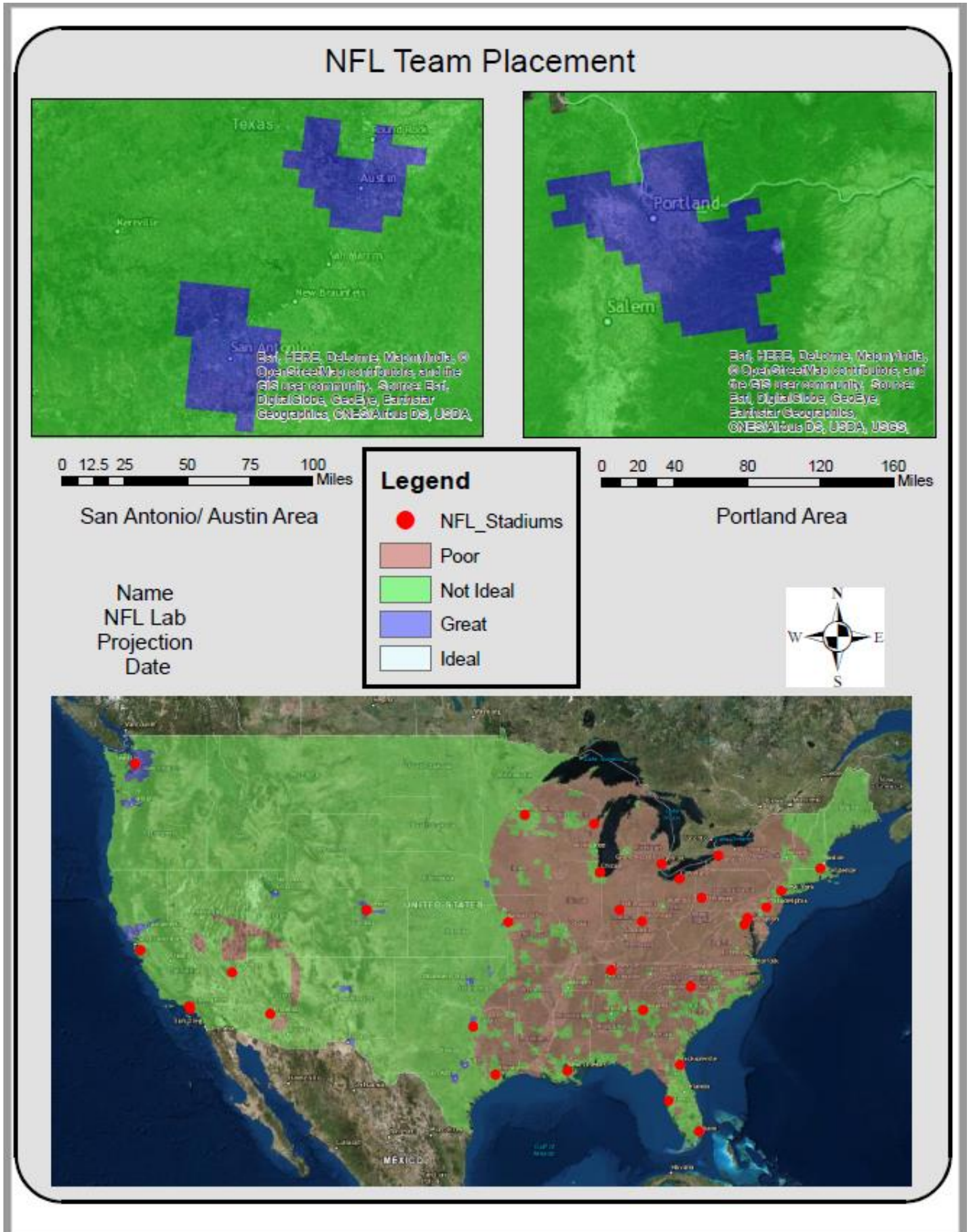Using the data referenced above, create a professional map layout showing a background map of the Continental US with current team locations and your results. Your map should include at least 2 close up data frames of the specific locations that you believe would make ideal locations for team placement. Write a report the project requirements, your approach to solving it, a description of the model that was used to solve it, an explanation of the locations that you identified as ideal places for new NFL teams, and the resulting map and model. Be sure to review the rubric at the end of this chapter for the full requirements of this laboratory exercise.

References

Bolstad, P. (2008) GIS Fundamental: A first Text in Geographic Information Systems. 3rd Edition. Esri Publishing.

Example Map

Rubric for NFL Team Placement

Item	Points
Assignment Title, Author Name, Date, Course Name	/5
Brief summary of the requirements of the project	/5
Describe your model • List each of the tools used: (2 pts) • List tool settings applied for the analysis: (2 pts) • List all input, intermediate, and output datasets: (2 pts) • Describe each input dataset including type (pint, line, polygon, raster) and the source of the data: (2 pts) • Describe each output dataset (point, line, polygon, raster): (2 pts)	/10
• One or more full pages (**8.5x11**) showing your model: (5 pts) • All text is readable (**10-point font minimum**): (3 pts) • All tools and data sets are shown: (2 pts)	/10
• Where are the best locations in the continental US for new NFL teams? (2 pts) • Why were these places selected? (3 pts)	/5
Make a full page (**8.5x11**) map showing the identified location(s) for the optimal NFL team placement. • Show existing NFL team locations and optimal locations for new teams: (4 pts) • Map Legend with Site Classifcations (1pt) • Map Title: (1 pt) • Neat Line: (1 pt) • North Arrow: (1 pt) • Scale Bar: (1 pt) • All features (future team locations) are labeled: (1 pt) • Text box with author name, date, map projection: (1 pt) • NFL team locations marked with well-defined symbol: (1 pt) • Background map is visible: (1 pt) • Zoomed to an appropriate scale for viewing all features: (1 pt) • All text is legible on printed map: (1 pt)	/15
Bonus Task: Add a bonus task to complete the exercise including Hawaii (and Canada?)	Instructor's Discretion