Determining Cell Phone Tower Placement in Maine

Overview

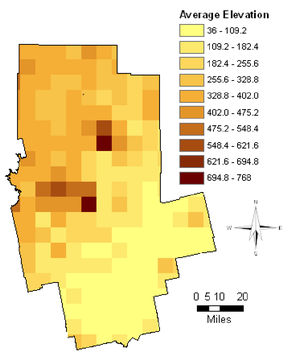
Many important factors must be considered when determining the placement of new cell phone towers. Towers must be placed in such a way that they reach the most people, while trying to avoid unnecessary overlap with already well covered areas. GIS is a useful tool to visualize as well as analyze many of the factors that go into deciding the best areas to build a new cellular tower. This study hopes to use a simplified model of the elevation, current tower coverage, population densities, land conservation areas, and road maps in two counties in Maine to determine the best placement of new towers.

Study Area

The area studied were the two adjacent counties of Penobscot and Piscataquis in Maine. Penobscot contains my home town, Bangor, which is the second biggest city in Maine and is located at a low elevation near a river. Piscataquis contains Baxter State Park and home of the highest mountain in Maine, Mt Katahdin. These two counties show a good range from low to high elevations, plus they range from urban to rural settings. This gives us a good, diverse area to utilize Raster Analysis and determine the best placement of new cell phone towers.

Methods

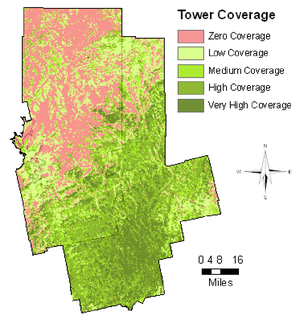
Analysis of tower placement factors was based on the estimated coverage range for each tower and the quality of the area it covered. Four factors went into determining the quality of the newly covered area: current coverage, population density, conservation regulations, and roads. Current coverage was determined by creating a viewshed based on current tower locations throughout Maine. The viewshed takes into account each tower's height and determines every point visible from the top of that tower. Population density, conservation areas, road maps, and elevations were all taken from the sources listed under information. Raster analysis was used to divide the areas into simplified grids, with each grid receiving a score for each factor. Current coverage was considered most important, as the areas with little to no coverage are the areas most in need of cell phone reception. Zero coverage was given a score of 10, low coverage a score of 6, medium coverage a score of 4, high coverage a score of 2, and very high coverage a score of 1. Population density was considered the next most important. A score of 1-8 was given to each grid based on population density. Next was the road systems. There are three main classes of roads, given scores of 2, 3, and 4 based on how large the road system was. From the sum of these three factors, each grid was given a **raw score**. Next, if the grid was mostly comprised of conservation land, it is illegal to build there and the grid was given a final score of zero. Otherwise, elevation was the next factor to consider. Using the elevation grid to the left, the **final score** of each grid was the raw score + the raw score of all grids surrounding that were lower in elevation than the grid. This is to show that towers will cover space outside of their grid, unless they are blocked by areas of higher elevation. The highest finals scores were used to determine the best areas for new cell phone tower placement.



Placement Factors

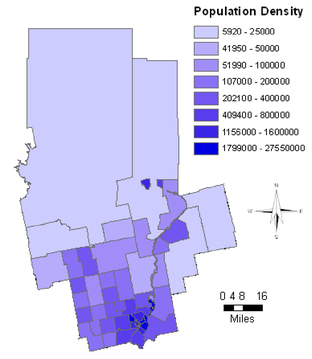
Current Coverage

Areas with less coverage are given more weight with a bias towards zero coverage areas. Low coverage implies 1-2 towers, medium coverage implies 3-5 towers, high coverage implies 6-20 towers, and very high coverage implies over 20 towers.



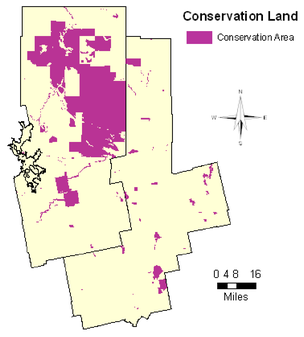
Population Density

Towers that provide coverage for areas of larger population are given more weight. Populations are is taken from the 2000 census data from the US Census Bureau. The population density is persons per square mile.



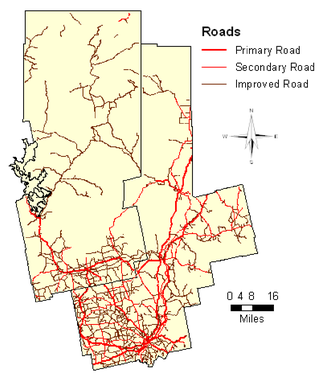
Land Conservation

Conservation land is protected wildlife areas where construction is prohibited. Potential tower placement was disregarded if the point was on top of conservation land.



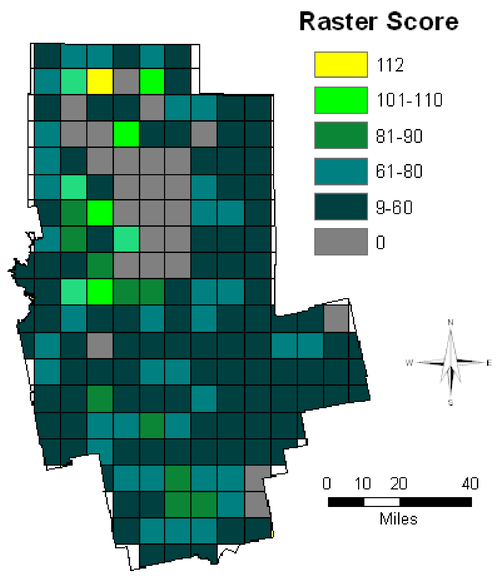
Roads

Major roads imply more traffic, therefore the larger roads are given more weight. Roads sizing from interstates to improved roads were considered, while unimproved roads, trails, and footbridges were omitted.



Results

The results shown below show the final scores for each grid analyzed in the two counties. The highest scores show the areas best fit for building a new cell phone tower. The low scoring grids show placements that are either already well covered or would not reach enough of the population to be considered useful. The results themselves show strong tendency towards northern Maine, where the coverage is very low to non-existent. As to be expected, areas in valleys or next to high elevations received much lower scores than those on peaks or adjacent to similar elevations.



Conclusion

The raster analysis to the left shows strong scores for areas in northern Maine. These results make sense, as this is the area with the least amount of coverage. Based on this analysis, if one new tower were to be built, it would be built in the area colored in yellow. The results look good, but the study itself is a very simplified model with many limitations. For instance, cell phone towers themselves don't necessarily give coverage to every point visible to it. There are many equations having to do with distance and weather conditions that affect how far a tower signals. These factors were not taken into account for the purposes of this study. Also, the factors considered by this study are by no means complete. Ease of access to the area, land types, land regulations other than conservation and many other factors go into determining where to build a tower. Of course, also to be considered is the fact that the grids cover very large areas and therefore produce numbers that are not very precise. However, this is a simplified model, and still shows the usefulness of GIS software in analyzing potential placement areas. Considering the limitations of the study, the results still turn out useful information towards determining the placement of new cell phone towers.

Information

Cartographer: Daniel Malmer
Course: Intro to GIS
Semester: Summer 2009
Projection: NAD 1983 UTM Zone 19N
Sources: Maine Office of GIS, 2000 US Census Bureau, USGS National Map Seamless Server