Introduction

The Santa Monica Mountains National Recreation Area (SAMO) in southern California is bounded on the east by Los Angeles and on the south by the Pacific Ocean. The 150,000+ acre (240 square mile) area contains a mixture of mostly parkland - including four state parks occupying about a quarter of the SAMO area - interspersed with residences and roads. I lived and worked near the SAMO for 8 years and regularly enjoyed hiking, biking and maintaining many of its 430+ miles of trails. Now living in Colorado and studying GIS, I explored this area in a different way using ArcMap, where I created maps and reports with features I struggled to find when I lived in the region. Which moderately strenuous trails can I bike on? Where can I hike with my dog in the Topanga area? This paper outlines how I organized my project so that I could answer questions like these.

Objectives

My goals for this project were to produce a geodatabase, layout maps and reports focused on the trails in this area. I would provide a meaningful backdrop of spatial information to showcase my two items of special interest: indicators for trail usage, and trail difficulty ratings. These items could be viewed separately or in combination for any area of the SAMO, with clear and appropriate symbolization and labeling on map layers, layouts or reports. This functionality was sometimes present in maps I'd seen online or in paper format, but my approach was to be applied more comprehensively over the SAMO and with the capability to combine the features.

Procedures

I started by creating a file geodatabase and locating and downloading suitable data for my layers. I then developed the map background and added fields to trails for trail use and trail rating.

For the background layers, I wanted to provide helpful and clear orientation for the viewer of the maps or geodatabase. I found spatial data for park, city, county and fire boundaries; and roads, trails and hydrology line data. These were in several different formats, including shapefiles, geodatabase feature classes and an ArcGIS Online 'web map', and also were in a variety of coordinate systems: geographically, I was blessed with the mixture of NAD83, NAD27 and WGS84. I recalled a suggestion that it is better to transform NAD27 to NAD83 than to WGS84, and also my focus trails layer was in NAD83, so I chose NAD83 as my geographic coordinate system. Several of the data sources were in UTM-Zone 11, which I adopted as my projected coordinate system. I used the Project tool to project/transform data in other coordinate systems to NAD83 - UTM Zone 11. From there, I clipped hydrology, state parks and fire perimeters to the SAMO boundary; trails to 1/2 mile and cities to 5 mile buffers around the SAMO boundary; and roads to the two counties (Los Angeles and Ventura) that contain parts of the SAMO. With roads, I also combined 3 feature classes (interstates, highways and roads) into one using the Merge tool. To my resulting map layers I applied appropriate symbolization and labeling.

My next step was to develop and join trail use information: whether you could bring your dog, bike or horse on a trail. I compiled this information primarily from paper maps I have of this area, with some additional confirmation from online sources or books. With 499 possible trails to designate, I focused my attention on the state parks in the SAMO for now, and will try to revisit the remaining areas at a later date. I also included a spatial join to the state park data to get a state park name field within the trails layer, and added another field with calculated miles of trail.

My final processing step was to add the trail difficulty ratings. I had discovered a tool in the 3D Analyst extension called "Add Surface Information" that adds fields for min, max, mean elevations and slopes from an elevation raster to a feature class. I located digital elevation models (DEMs) for the SAMO, finding two 1/3 arc-second resolution rasters covering the area. I brought them together using an Append tool, and happily found the 100 meter overlap joined quite seamlessly. After applying the Add Surface Information tool, I brought the data into Excel to perform additional analysis, focusing on trails over a half mile in length to filter out some 'noise'. Comparing the measures against my experience on the trails and to a few maps and books I had that suggested trail difficulty, I came up with the following formula for (numeric) trail difficulty:

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(Z_Max - Z_Min) / Shape_Length * 1000
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I split the range of values produced from applying this numeric formula on the trails into 5 equally sized categories and assigned the following textual values accordingly: easy, mild, moderate, strenuous, very strenuous. Reviewing the results of applying this formula, I was quite happy with the outcome: 'very strenuous' trails were well in agreement with my experience and map tables, and most of the 'easy' trails were pretty flat. I did see some room for improvement, though, in that some of the 'easy' and 'mild' trails were actually more strenuous than their indicator suggested. I realized that a trail which goes up and down several times along its course would produce such a conflicting result and impression. As a first approximation, though, I felt my trail rating performed satisfactorily, and moved on to presentation aspects.

Results

1. Map Layout of Springs Fire and Point Mugu State Park

Another item of interest for me was to explore the reach of the Springs Fire, which started on May 2, 2013 a few miles north of the northwestern boundary of the SAMO. Hot, dry, windy conditions quickly spread the flames south to the coast. The blaze burned over 24,000 acres in a day and a half, including nearly all the trails within Point Mugu State Park.

In preparing the layout, it was challenging to achieve appropriate symbolization without making the map feel cluttered or confusing. I chose to include 2 insets showing extent indicators, so that viewers could be oriented appropriately, and included some textual information about the fire.

2. Report presenting multiple features at once

As mentioned earlier, one of the problems I wanted to solve with this project was to be able to answer questions like: "which trails in the western end of the SAMO are very strenuous and allow bikes?" I found that producing a Report was an efficient way to show this information combination. A user of the geodatabase could also refer to the layers independently to view trails spatially by their use and rating for a region of the park selected by a bookmark or zooming in.

Challenges

Most of my challenges in this project revolved around data management issues. I hadn't really managed an ArcMap project on this scale in terms of the number of layers and processes involved. I found it helpful to use ModelBuilder intensively throughout the process to help with design just as much as for combining multiple steps into a process or showing representations of my models. Another data management challenge was in finding that field names change after joining data, impacting my subsequent application of existing layer files for symbolization. I wanted to rename several fields anyway, and also add/calculate several fields at once; I found

doing this with existing tools to be rather inefficient in that they only apply to one field at a time, so I turned to running Python scripts in ModelBuilder. This was really my first attempt at using Python (ArcPy) with ArcMap, and I struggled with parameters in particular. My scripts ran, but were a bit touchy; I suspect I will learn how to improve my outcomes with time and practice.

A few other ways in which I stretched my skills were in discovering I can save and manage a set of bookmarks, and the project gave me a practical reason to edit metadata. The Reports functionality in ArcMap held some surprises for me: I initially expected to do a summary report with this feature, but after some research it seemed like this is not really what reports are for... but it dawned on me that my multiple-feature display goal was well-suited to implement with reports.

Conclusion

Using ArcMap, I created a geodatabase and maps with layers for viewing trails symbolized by use and difficulty, along with meaningful background layers portraying the Santa Monica Mountains NRA and surrounding vicinity. I created a Report showing trails in a particular region of interest sorted by difficulty and use characteristics combined. The procedure worked well, and results could be refined by completing the trail use designations and revisiting the difficulty rating formula to fix the problem of a small number of the trails being marked as too easy. Given availability of trail and use data, the procedure could also be extended to other areas, including to parks and trails here in Colorado where I now live.

Acknowledgements

My data layers came from the following sources. It should be noted that most of the more local sources held disclaimers to the effect that the data could be used in a general sense but should not be used for wayfinding, official or legal determinations.

- Trails: ArcGIS Online, *Public Trails in the Santa Monica Mountains National Recreation Area*, by NPS. Last modified March 2015.
- Roads, hydrology, SAMO and city boundaries: SAMO small scale base GIS water quality data from *IRMA (Integrated Resource Management Applications)*. Released January, 2001.
- Elevation rasters: *The National Map*, National Elevation Data: 1/3 arcsecond digital elevation models for n35w119 & n35w120. As of January 2013.
- Fire perimeters: *California Department of Forestry Fire and Resource Assessment Program (CDF-FRAP)*. Through July 2014.
- Park boundaries: State Park boundaries, as of March 2012.
- County boundaries: Census Tiger/Line shapefiles, 2015
- Trail use designations: *National Geographic Maps Trails Illustrated #253-Santa Monica Mountains National Recreation Area* (a paper map), 1998.