How Crowd Sourcing Can Inform Management Decisions in the National Forest

Introduction
Natural resource managers rely on quantitative data to make decisions about how to create and maintain built capital and natural environments. The US Forest Service (USFS) is one such management agency that is responsible for managing limited recreational resources. In order to come up with strategies to maximize the utility of our public lands, land managers need up-to-date information about visitation.

Visitors to the national forests sometimes upload photos with geotagged coordinates to social media websites like Flickr. A geotag is an electronic signature that assigns a geographical location to a photo. In this report, visitor permit data and photo user data are used to project visitation on trail systems in the Mount Baker-Snoqualmie National Forest.

Methods
We analyze monthly visitation counts for 31 trailheads from the Skykomish and North Bend districts of the Mount Baker Snoqualmie National Forest from 2011 to 2014. From the USFS, we obtain publicly available digital records of wilderness permits, a daily count of the number of recreational visitors entering into wilderness in the national forest. From Flickr, we take photos and test each geotag to see if it refers to a location in the national forest. To test whether each geotag refers to the MBS National Forest, areas corresponding to each trail system were mapped out in GIS. The maps were drawn according to USFS trail records derived from GPS. Then, from the remaining photos we count how many are taken by unique accounts on unique days and call the sum total “photo-user-days” (PUD).

Results
We find that PUD is a statistically significant predictor of national forest visitation, meaning that land managers can use photo data from Flickr to predict visitation. Results from the pooled regression model are shown in the scatterplot to the left. PUD explains a significant proportion of variation in national forest visitor counts at the 0.01 confidence level.

When grouped by trail name, PUD explains a significant amount of variation in national forest visitor counts in 26 of the 31 trails.

Discussion
The national forests are a treasure of American society. They span over 193 million acres, an area larger than the state of California. 140 million Americans participate in some form of outdoor recreation annually and that number is increasing by one million people every year. The USFS has a mission to meet the needs of present and future generations, and it is a monumental task for land managers to create and maintain built capital and natural environments. They have to make important decisions about how and where to allocate resources. My study shows that social media can be leveraged to help validate and support official records so that managers can make more informed decisions. This study demonstrates the effectiveness of using social media data and official records in order to enhance decision-making for our public lands.

These results show that a given photo user day predicts a positive relationship with registered permits on trail systems in the MBSNF. The pooled regression does not however guarantee the best predictive model for individual trails in the national forest. The national forest consists of a large variety of trails which may each have their own relationship between PUD and registered permits. The relationship between PUD and permits can be further specified by referencing the grouped model where a different linear model is fit to each trail. The grouped regression gives unique statistics about individual trails presumably latent differences among the trails that influence visitation. Latent variables in the grouped regression could include the popularity of a trail, its scenic value, the amount of garbage littered on the trail or whether dogs are allowed.

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