

Blazing Trails in the 21st Century: Using Electric Bikes to Map Trail Conditions in National Parks and Beyond

Pat McMahon

Advanced Public Lands Transportation Fellow
National Park Service – WASO Transportation Branch

Abstract

The National Park Service (NPS) is piloting an innovative trail condition assessment and mapping methodology.

Using electric bicycles (eBikes) equipped with a camera and sensor system, the 'Trailblazer' eBikes efficiently collect high-quality, objective trail condition data.

The system captures photographic, accelerometer and annotative data, which is mapped and organized in a geodatabase, and used to inform trail maintenance and management decisions.

Beyond NPS trails, the Trailblazer eBikes present a cost-effective and easily transferable methodology for other federal, state and local organizations to assess the condition of their trail networks.

Background

Transportation Trails

- Subset of NPS trails
- Provide alternative access to National Parks without use of car
- Necessitate more detailed condition information than existing rating system

Project Funding

- Federal Highway Administration's Innovation and Research Council (FHWA IRC)

The Trailblazer eBikes



eBikes

- Specialized Como 4.0 (from ElectricCity Bikes in Washington, DC)

Camera and Sensor System

- Smart Pano Camera from Smart Delta
- Mounted on front rack of bike

Tablet

- Samsung Active Tab 3.0

Data Collection



Camera and Sensor Collections

- 360-degree 4k geolocated photographs captured every second
- Accelerometer records 'roughness' of trail, collects 200x readings per second
- Accelerometer data processed to output maximum z-axis value per meter with coordinates

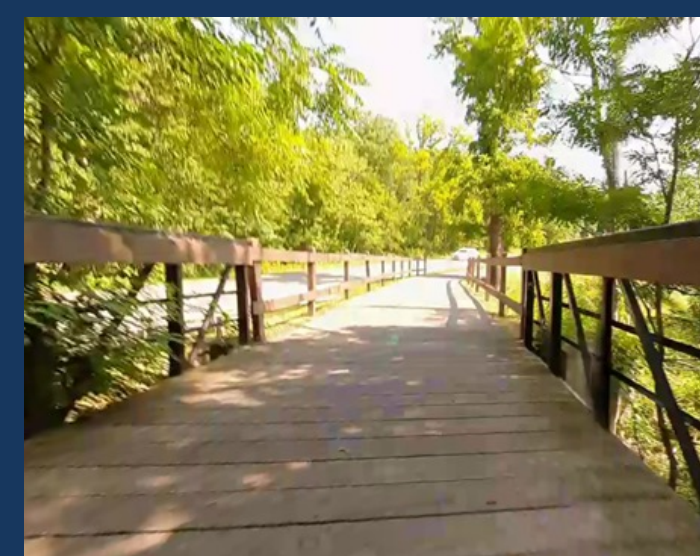
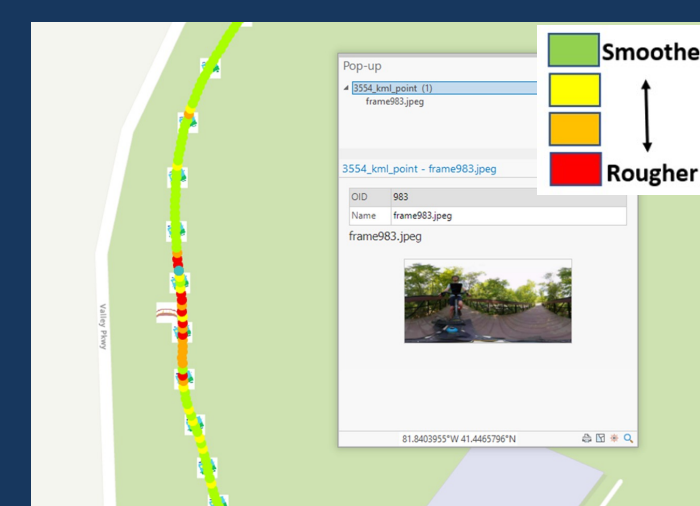
Tablet Interface

- Camera interface streams directly to tablet mounted on handlebars
- Supports custom annotation buttons allowing riders to record annotations at current location without stopping ride

Annotation Examples

1. Bridge
2. Congestion
3. Crosswalk
4. Hazard
5. Trail Surface Material Change
6. Milepost
7. Slow/Stop
8. Vegetation

Mapping

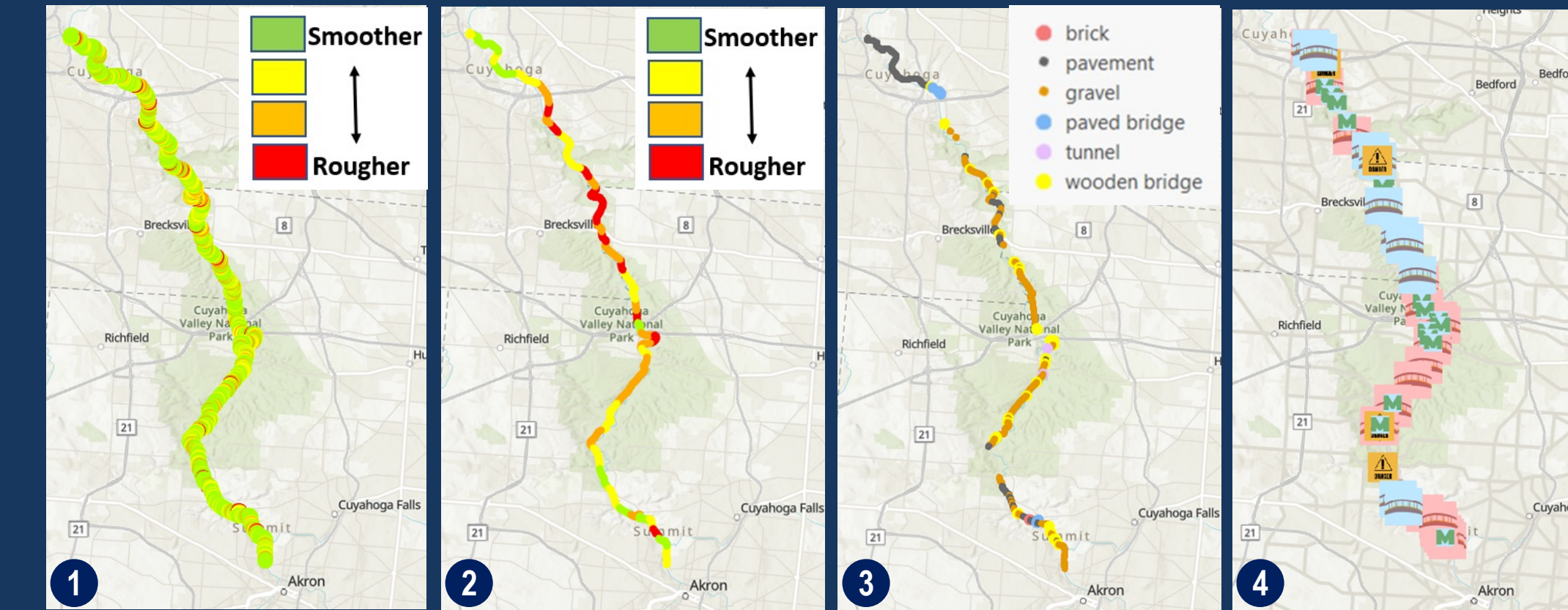


Geodatabase as Analysis Tool

- Example (left) demonstrates photographic, annotative and accelerometer data layered together in ArcGIS
- Photographs can be opened in 360-degree viewer within ArcGIS
- Allows trail managers to cross-reference accelerometer and annotative data with photographs imbedded in map

Findings

Cuyahoga Valley National Park: Towpath Trail



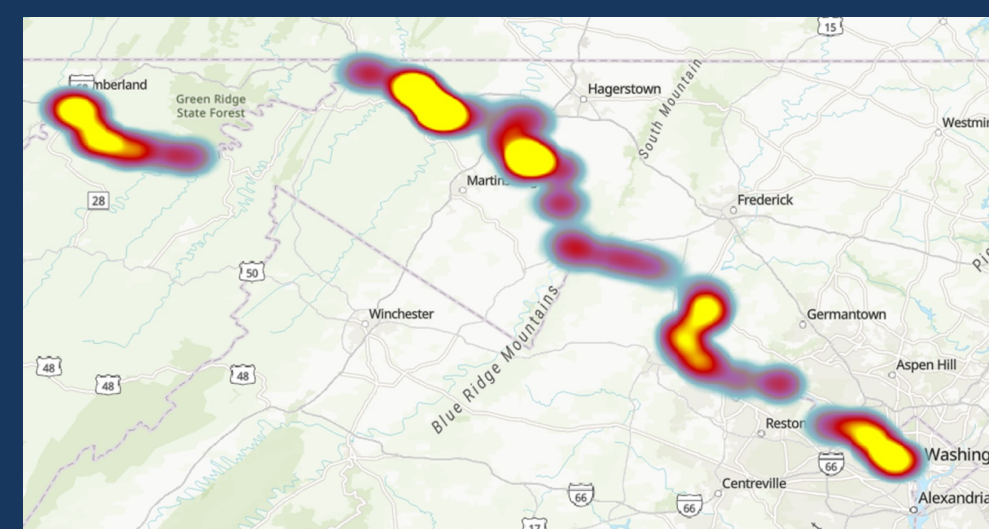
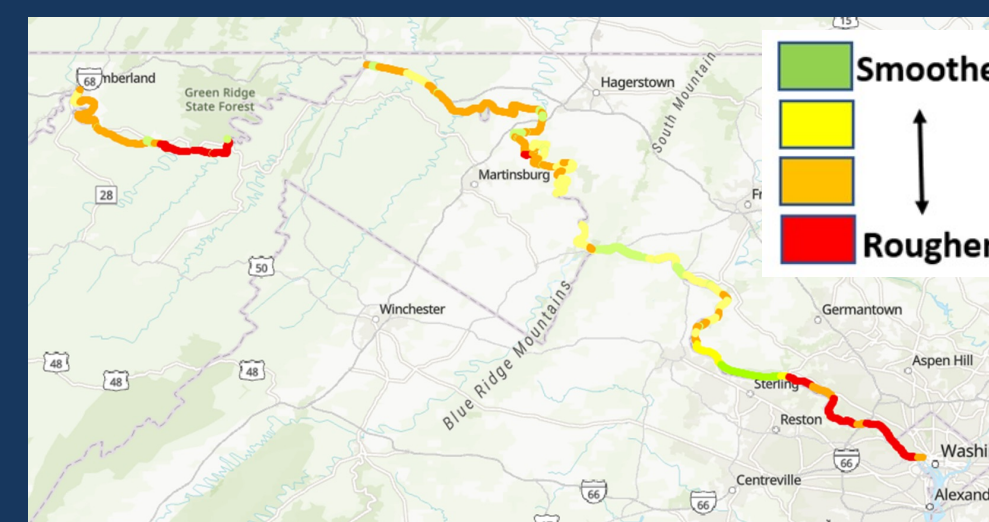
Map Descriptions:

1. Maximum z-axis accelerometer value per meter (roughness)
2. Roughness averaged by half mile
3. Trail surface material
4. Annotative data

Trail Description

- Runs along former Ohio & Erie canal alignment and Cuyahoga River corridor
- 20 miles within CVNP, connects populous Cleveland and Akron metro areas

Chesapeake & Ohio Canal NHP: Towpath Trail



Trail Description

- 185 miles from Cumberland, Maryland to Washington, DC
- Runs along former Chesapeake-Ohio Canal and Potomac River corridor

Map Descriptions

- Top: Maximum z-axis accelerometer value per meter averaged by mile
- Bottom: heatmap of vegetation overgrowth along trail

Utility

- Identifies trail segments in greatest need of attention and maintenance, helps trail managers prioritize focus areas
- Causes of poor condition like potholes or rutting can be pinpointed with 360 photos in GIS
- Annotations pinpoint hazards, infrastructure and user patterns of interest to trail managers

Potential Applications

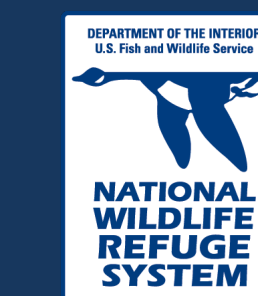
- Could be expanded for NPS service-wide use and/or partner use
- Cyclic assessments can track trail condition change over time
- Trail signage, access points and infrastructure inventories
- Post-storm or flood damage survey tool for trails
- Virtual tours of trails in Google Streetview style

Variables and Considerations

- Speed and weight impact accelerometer data, important to keep both variables consistent for duration of collection
- Length of eBike battery life dependent on level of use and weight
- Different trail materials result in different accelerometer value distribution, must be considered when interpreting accelerometer data
- Accelerometer data visualization is relative to distribution of entire dataset, does not reflect any fixed numerical categories

What is the Public Lands Transportation Fellows (PLTF) Program?

The PLTF program provides fellowships to recent graduates in a transportation-related field. The fellows are provided with a unique opportunity for career development and public service working directly with staff of Federal Land Management Agencies (FLMAs) on key visitor transportation issues. The assigned projects help the land units develop transportation solutions that preserve valuable resources and enhance the visitor experience. *List of sponsors below.*



U.S. Department of Transportation
Federal Highway Administration



MONTANA
STATE UNIVERSITY

Western
Transportation
Institute