

ANTICIPATED
TIMELINE

EXPECTED
RESULTS

ANALYSIS

FIELD
TEST

DATA

METHODS

PROJECT
PROPOSAL

BACK-
GROUND

INTRO

Trail Difficulty Per Segment

A GIS Based Analysis of Hiking Trails

Lisa Dubas
Capstone Project Proposal
October 30, 2017

Introduction

When it comes to hiking ratings,
there is no one-size fits all approach.

Arizona
Trail
Rating
Examples

National
Rating
Examples

Private
Rating
Examples

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- The 13.7 mile North Kaibab trail at the Grand Canyon has the most accumulated elevation loss, at -5,790 feet

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- There are 4,699 hikes within the State of Arizona
- The 13.7 mile North Kaibab trail at the Grand Canyon has the most accumulated elevation loss, at -5,790 feet
- The 755 mile Arizona trail has the most accumulated elevation gain, at 82,000 feet

Arizona
Trail
Rating
Examples

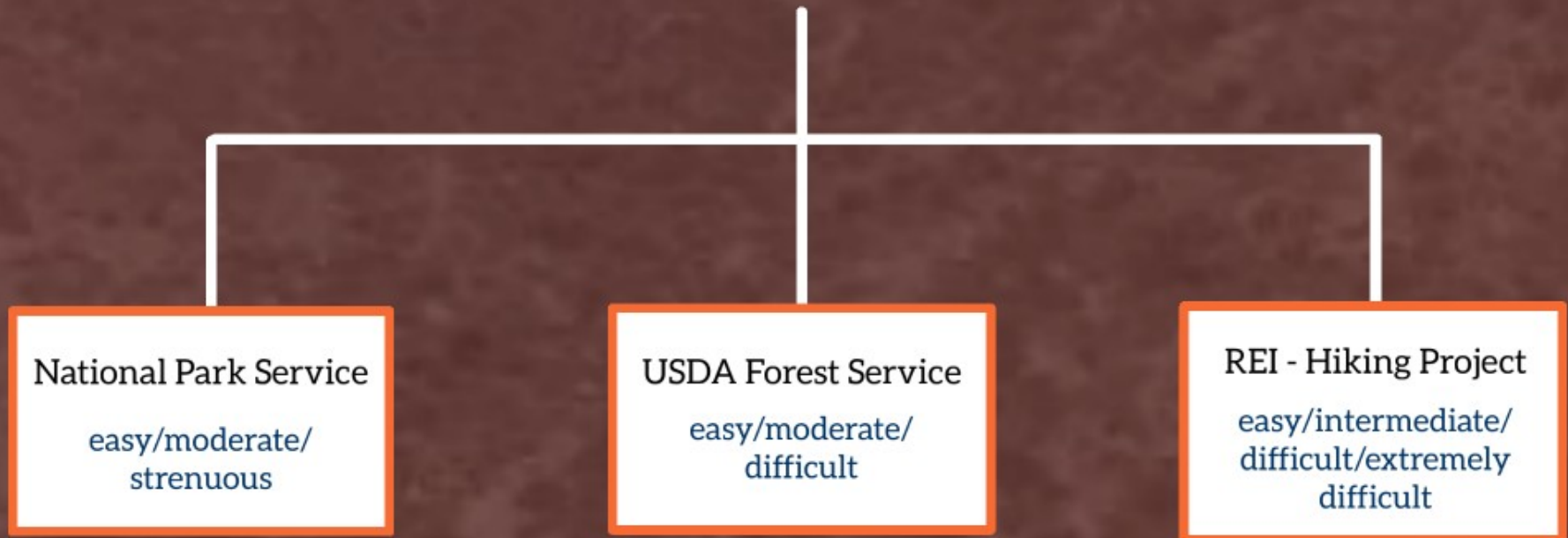
National
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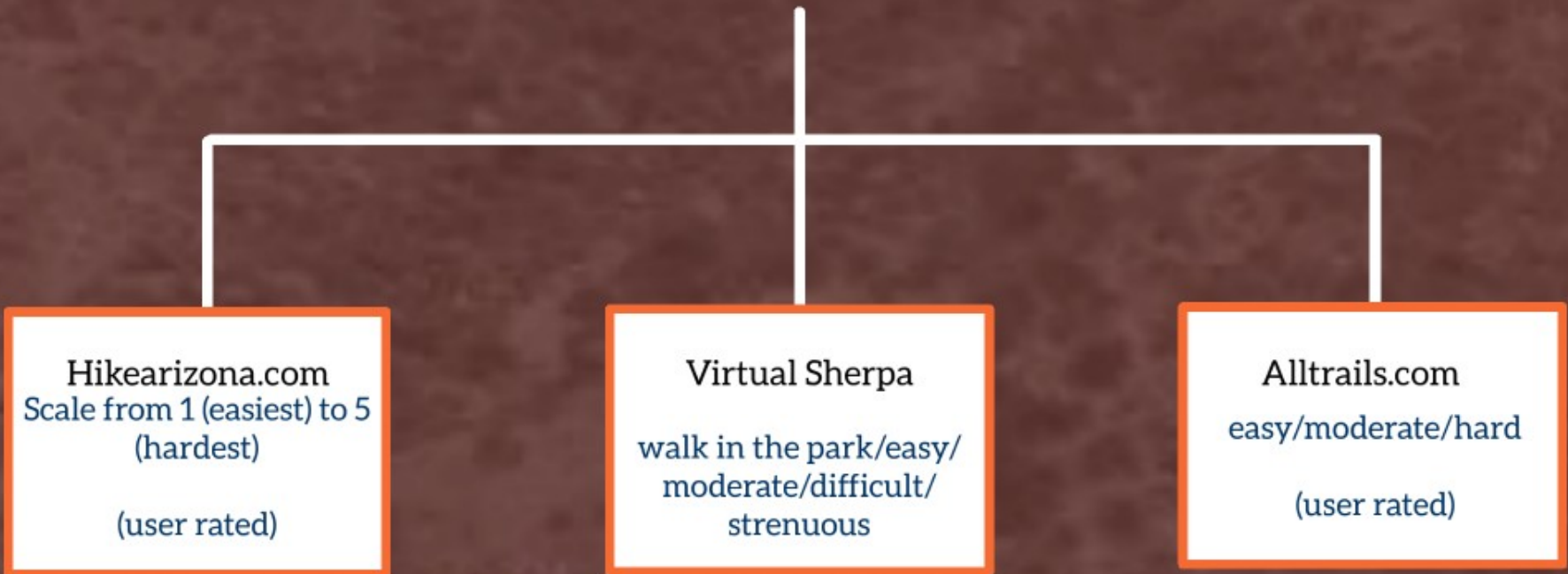
Trail Rating Examples in Arizona

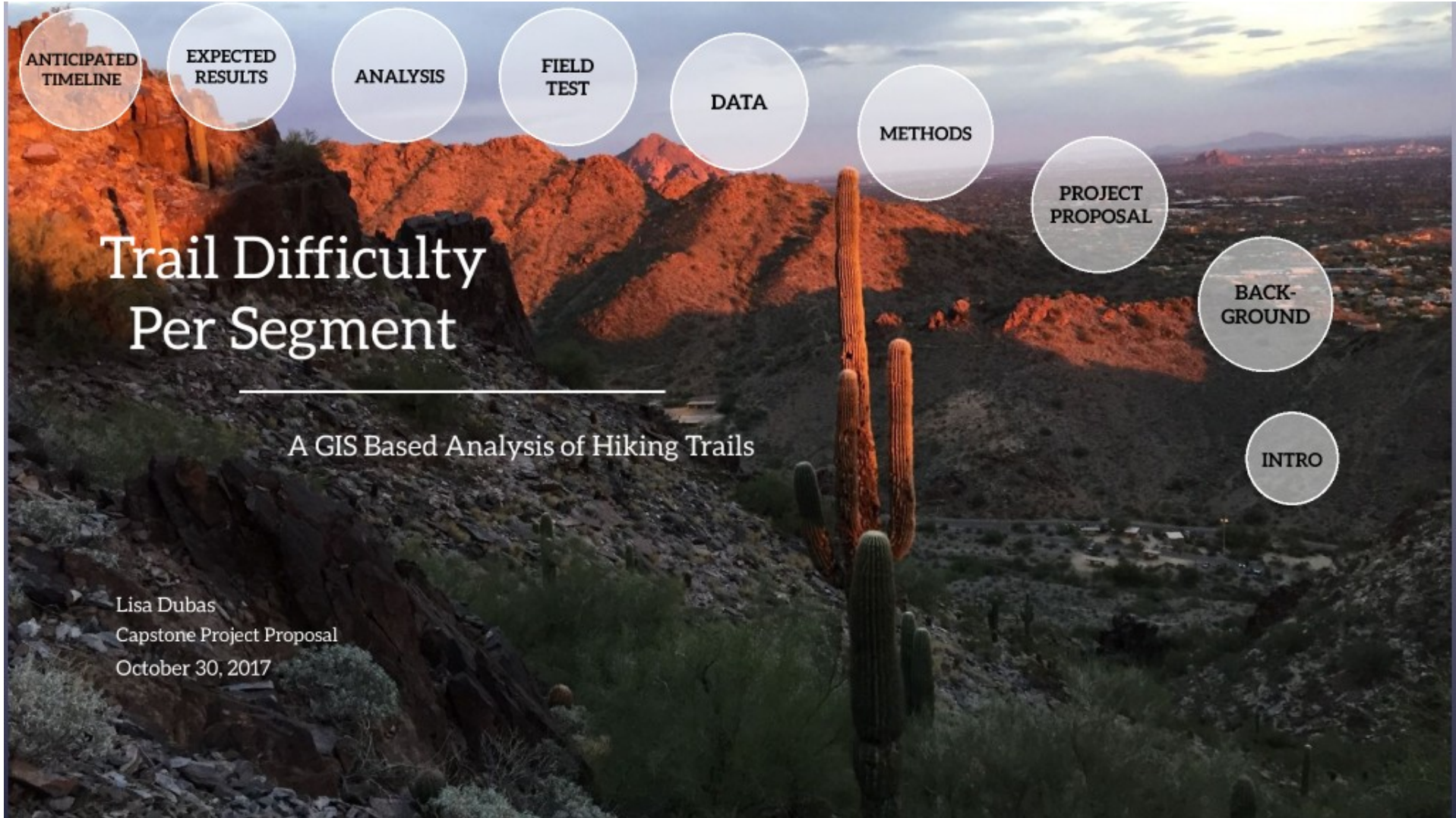


National Rating Examples



Private Rating Examples





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I want to go
on a hike ...



Hiker
Research

Problem
with
Research

Existing
Solutions
?

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I want to go
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- Look for a hike in a
local hiking book

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Does that
hike fit my
level of
fitness ?

Hiker
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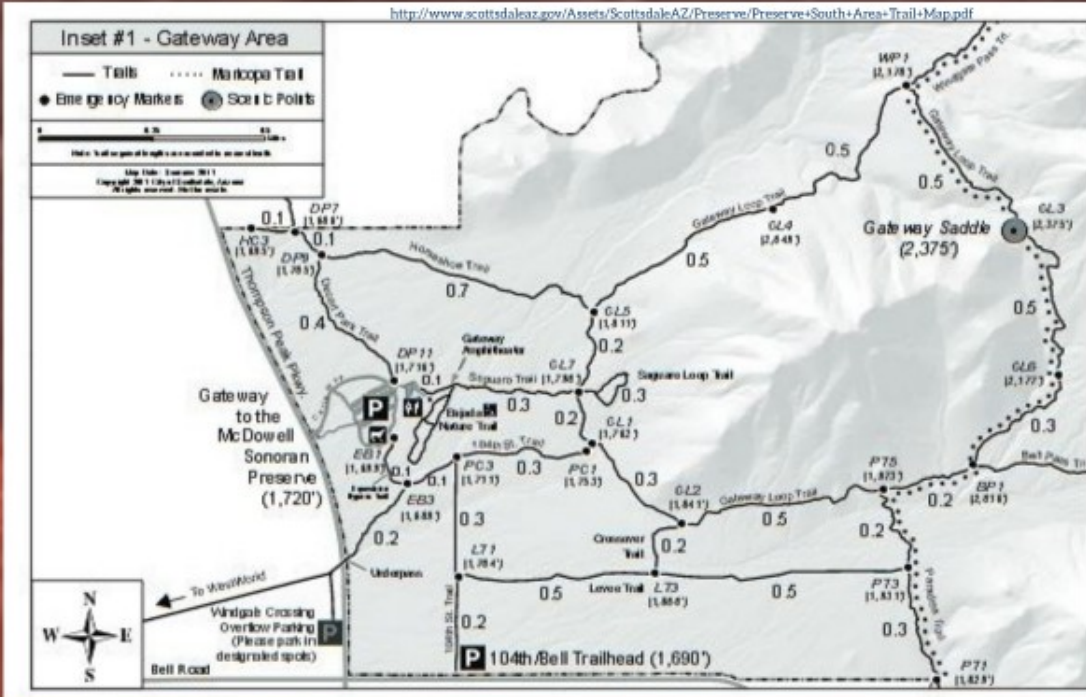
Problem
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GATEWAY LOOP

McDowell Sonoran Preserve - Scottsdale

<http://www.scottsdaleaz.gov/Assets/ScottsdaleAZ/Preserve/Preserve+South+Area+Trail+Map.pdf>



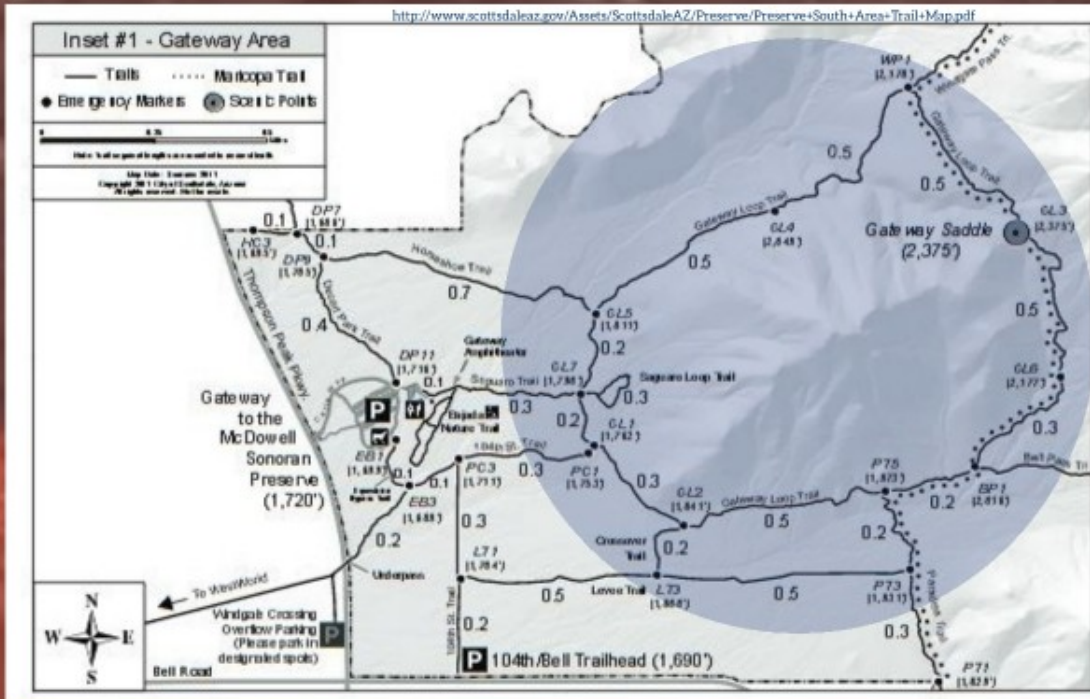
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Anasazi Spur	0.5 / 0.8	●	71 / 21
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Caballo	0.4 / 0.6	●	59 / 18
Desert Park	3.1 / 5.0	●	606 / 182
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Equestrian Bypass	0.3 / 1.2	●	41 / 12
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Gateway Loop	3.6 / 5.8	◇	625 / 188
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Last Dog	2.6 / 4.2	■	380 / 114
Marcus Land Slide	2.3 / 3.6	◇	280 / 85
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Talisin	2.4 / 3.8	●	431 / 129
Thompson Peak Rd	2.2 / 3.5	◆	1614 / 484
! Tam's Thumb	5.0 / 8.0	◆◆	1363 / 409
Windgate Pass	3.1 / 5.0	◆	858 / 257
Windmill	1.0 / 1.6	●	113 / 34

Rating Symbol	Grade	NOTE: Please take extra precautions when temperatures and/or humidity are high.
○ Easiest	1:1	* No horses or bikes.
● Easy	1:2	! Experienced horse and bike riders only.
■ Moderate	1:3	
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McDowell Sonoran Preserve - Scottsdale



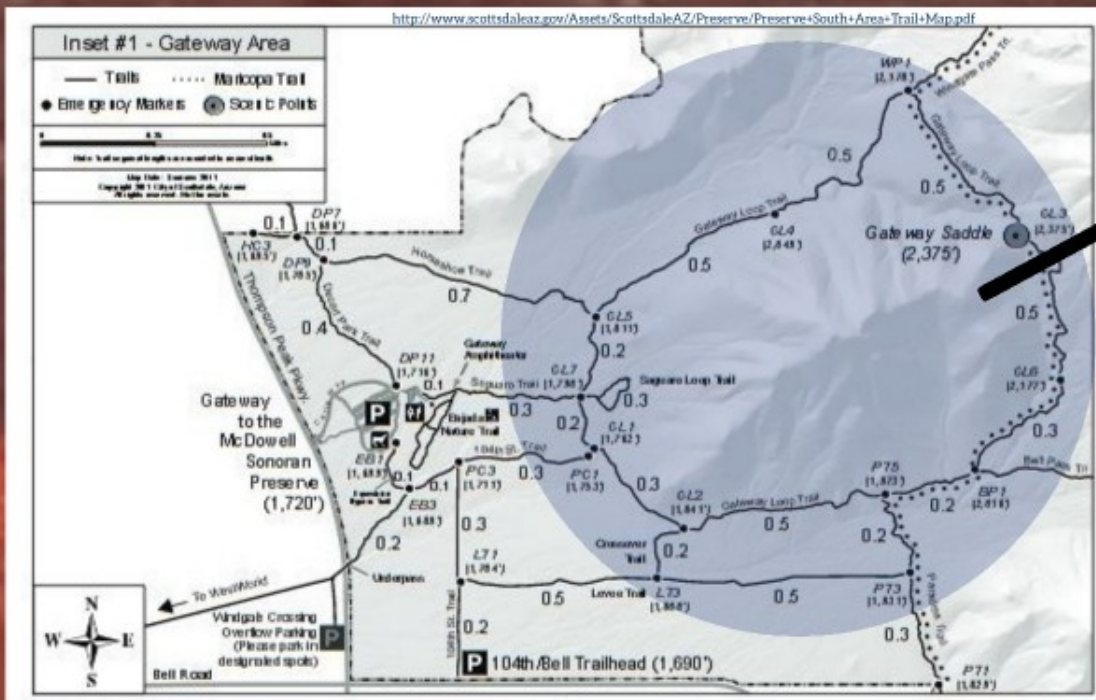
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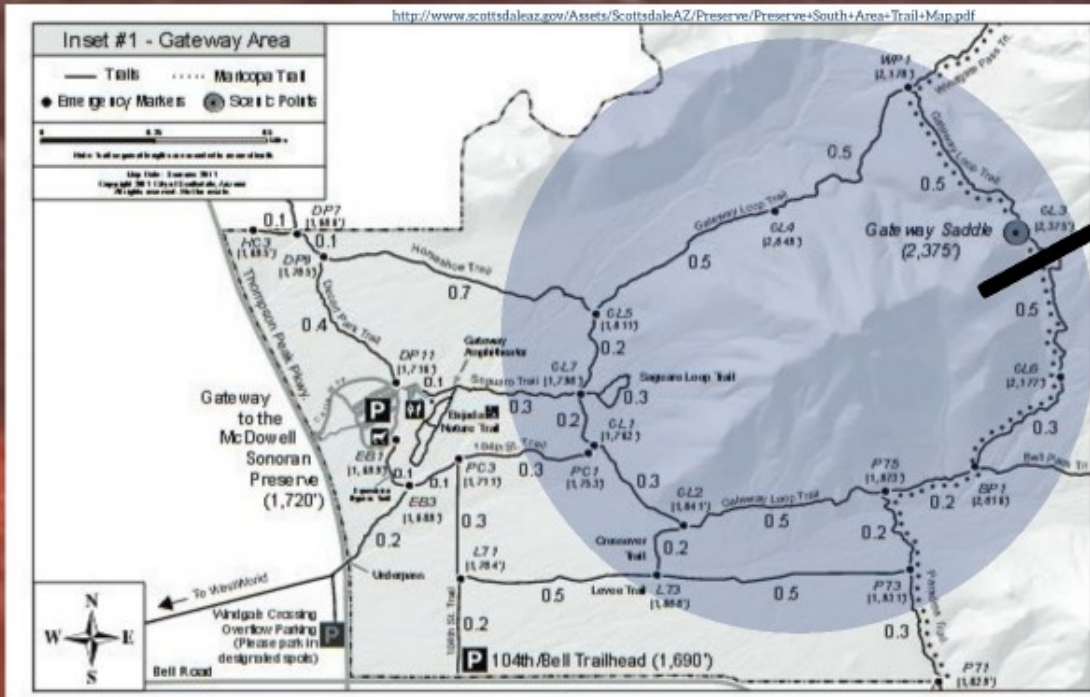


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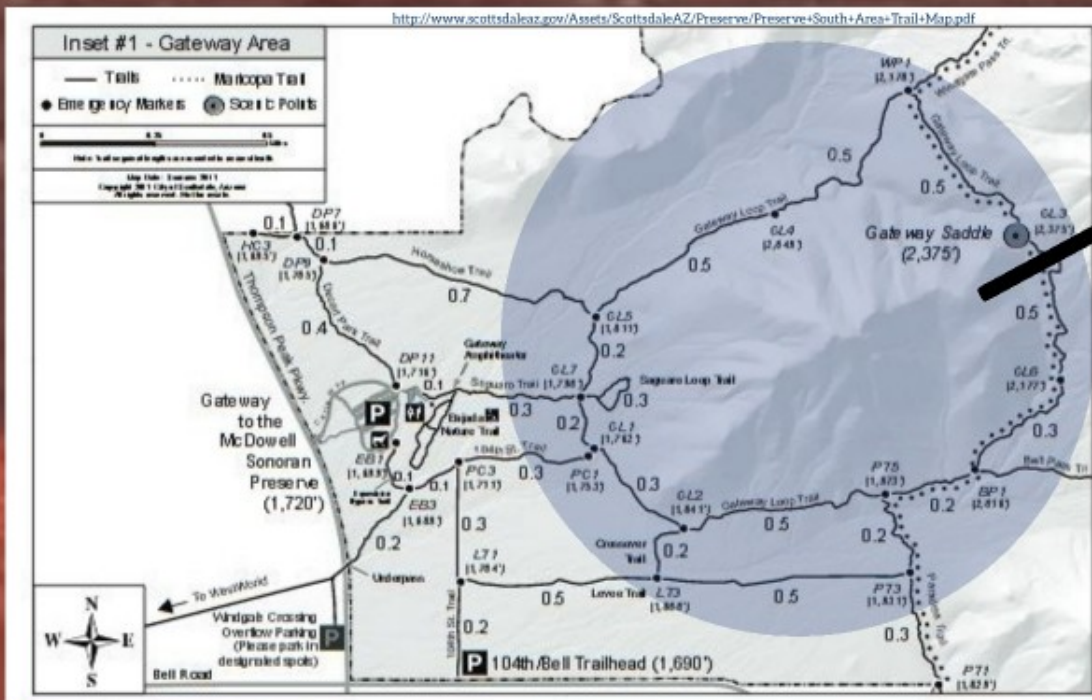


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◆	Difficult
◆◆	Extremely Difficult

NOTE: Please take extra precautions when temperatures and/or humidity are high.

* No horses or bikes.

! Experienced horse and bike riders only.

Trail ratings based on change in elevation from trailhead to the highest point, as well as City of Scottsdale's staff experience

THE PROBLEM WITH THIS APPROACH



GATEWAY LOOP

hikearizona.com
"1.5 out of 5"

City of
Scottsdale
"moderately
difficult"

Alltrails.com
"moderate"

Hiking Project
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"intermediate"



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EXISTING SOLUTIONS?

- All hike ratings are subjective and each rating is dependent on the experience of the hike rater

Kokopelli
Seeds

Universal
Trail
Assessment

Define
Subjectivity

Limitations
of Hiking
Ratings &
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But some have attempted to come up with a solution to this problem.

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hikearizona.com

Contributor Al_HikesAZ

- Realized hike ratings could be subjective
- Established the "Kokopelli Seeds" rating which he believed to be less subjective
- Kokopelli Seeds are based on the total miles and accumulated elevation gain

Example:
Gateway
Loop

Fault of
Method

GATEWAY LOOP

Kokopelli Seed System

Distance (loop) = 4.4 miles

Accumulated Elevation Gain
(up and down) = 838 feet

GATEWAY LOOP

Kokopelli Seed System

Distance (loop) = 4.4 miles

Accumulated Elevation Gain
(up and down) = 838 feet

Calculation: $4.4 \text{ miles} + ((838 \text{ feet up} + 838 \text{ feet down}) / 400) = 8.59$
Kokopelli Seeds

FAULT OF METHOD

Echo Canyon Trail on Camelback Mountain

Distance (loop)
= 2.3 miles

Accumulated Elevation Gain
(up and down) = 1,300 feet

Calculation: $2.3 \text{ miles} + (1,300 \text{ feet up} + 1,300 \text{ feet down}) / 400 =$
8.8 Kokopelli Seeds

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Gateway Loop was
8.59

Beneficial Designs


Administers the Universal Trail
Assessment Process

land managers are trained to rate
trails based on the following:

- trail grade
- cross-slope (drainage gradient)
- trail width
- surface firmness
- presence of obstacles

UTAP
Purpose

Fault of
Method



Purpose of UTAP

"enhance trail access and use for a wide variety of users, including older adults, inexperienced users, families and people with disabilities"

(from BeneficialDesigns.com)

Fault of UTAP Method

- The method is really meant to educate potential hikers who have accessibility issues

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- The method is really meant to educate potential hikers who have accessibility issues
- All five factors need to be measured every two feet with standard equipment that needs to be purchased

Fault of UTAP Method

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- All five factors need to be measured every two feet with standard equipment that needs to be purchased
- The trail measurements must be done by someone who has been trained to complete those measurements

Define Subjectivity

Virtual Sherpa (Mickey)

"I base each level of difficulty below for someone that has spent time in high elevation (over 9,000 feet) and can run at least two miles straight without stopping. If you find yourself saying, "2 miles are you F \$*#*%! kidding me?!" you may want to bump up the difficulty rating of the trail."

from: <http://www.thevirtualsherpa.com/virtualsherpa-hike-difficulty-rating-system/>



The Limitations of Hiking Ratings

- Every source rates the difficulty of hikes differently

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- Every source rates the difficulty of hikes differently
- All the hiking ratings discussed are per trail, or generalized per defined segment (such as between mile markers)
- None of these systems gives the hiker an idea of what they will encounter on the hike because it is all generalized

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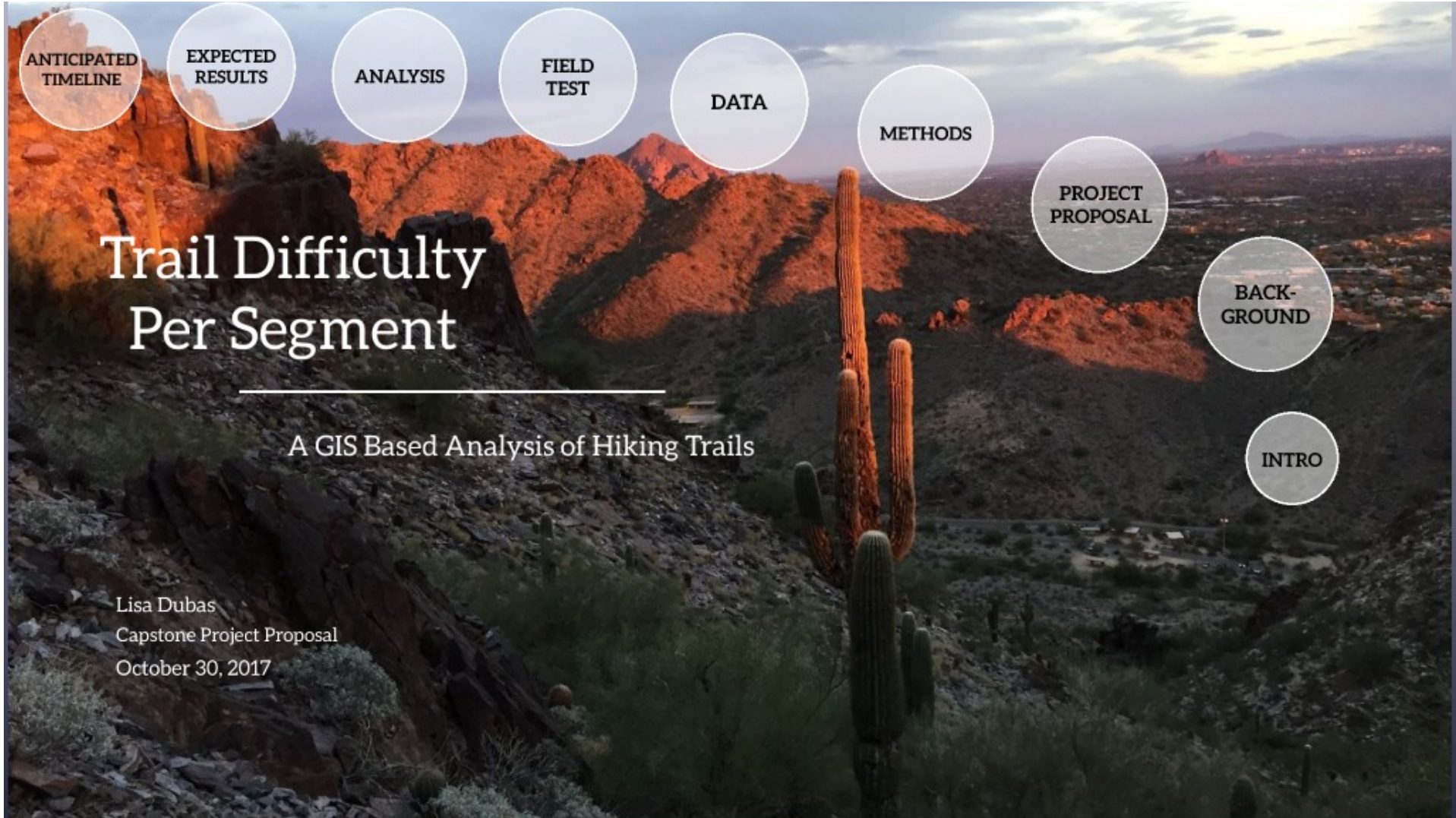
PROJECT PROPOSAL

- Use GIS as a tool to rate hiking trails according to difficulty per trail segment using a multi-criteria evaluation



PROJECT PROPOSAL

- Use GIS as a tool to rate hiking trails according to difficulty per trail segment using a multi-criteria evaluation
- Provide the resultant information in an online format that is easily accessible to hikers



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METHODS

Multi-Criteria Analysis

- Multiple layers are overlaid within GIS, each of which represents a **criteria** determined to be important in the decision making process
- The chosen **criteria** are **weighted** or **rated** and combined using GIS methods to aid in the decision making process

What
are
Criteria?

What is
weighted
or rated?

What are Criteria?

Criteria support the desired objective, which for this project is to rate the difficulty of trails per segment.

Project
Constraints

Project
Attributes

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Criteria support the desired objective, which for this project is to rate the difficulty of trails per segment.

There are two types of Criteria

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- Constraints - exclude data from the analysis (can be boolean layers)

Project
Constraints

Project
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What are Criteria?

Criteria support the desired objective, which for this project is to rate the difficulty of trails per segment.

There are two types of Criteria

- Constraints - exclude data from the analysis (can be boolean layers)
- Attributes - influence the objective of the analysis (hiking difficulty of a trail per segment)

Project
Constraints

Project
Attributes



PROJECT CONSTRAINTS

- Every analysis will be completed on an official maintained trail
- Trails selected for analysis will only be within Maricopa County



PROJECT ATTRIBUTES

- Total Distance
- Gradient
- Elevation Gain
- Altitude
- Trail Surface

These attributes were chosen based on a literature review that showed these items have been chosen most often by reviewers of trail difficulty.

Weighting / Rating

- What criteria are more important than the other criteria?

Methods of Weighting

Chosen Weighting Method

Weighting / Rating

- What criteria are more important than the other criteria?
- How will the criteria we have chosen effect the difficulty of a hiking trail per segment?

Methods of Weighting

Chosen Weighting Method

Weighting / Rating

- What criteria are more important than the other criteria?
- How will the criteria we have chosen effect the difficulty of a hiking trail per segment?
- Will every hiker agree on the weights assigned to the criteria?

Methods of Weighting

Chosen Weighting Method

WEIGHTING ATTRIBUTES

Ranking:

- easiest method but loses effectiveness as the number of criteria increases
- numerical weights can then be assigned using one of a number of methods

1 least
important
to 5 most
important

WEIGHTING ATTRIBUTES

Ranking:

- easiest method but loses effectiveness as the number of criteria increases
- numerical weights can then be assigned using one of a number of methods

Rating:

- suitable when a few simple criteria can be estimated with common sense or expertise in the area of study
- lowest weight = least important
- highest weight = most important

1 least important to 5 most important

weights would add up to a total of 100

WEIGHTING ATTRIBUTES

Ranking:

- easiest method but loses effectiveness as the number of criteria increases
- numerical weights can then be assigned using one of a number of methods

Rating:

- suitable when a few simple criteria can be estimated with common sense or expertise in the area of study
- lowest weight = least important
- highest weight = most important

Pairwise Comparison:

- comparison of criteria in pairs to create a ratio matrix
- requires a lot of effort, but only two criteria are compared at a time (reduces uncertainty)

1 least important to 5 most important

weights would add up to a total of 100

index values from 1 to 9



Weighting Method Chosen for Project

- Hiking ratings will always be subjective, no matter how the data is analyzed because every hiker is different



Weighting Method Chosen for Project

- Hiking ratings will always be subjective, no matter how the data is analyzed because every hiker is different
- Ranking method was chosen because it is easy and effective with fewer criteria

Weighting Method Chosen for Project

- Hiking ratings will always be subjective, no matter how the data is analyzed because every hiker is different
- Ranking method was chosen because it is easy and effective with fewer criteria
- A project goal will be to define the attributes in ways that are less subjective to all hikers

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A GIS Based Analysis of Hiking Trails

Lisa Dubas
Capstone Project Proposal
October 30, 2017

DATA

GIS Layers:

- Constraints
 - **Maricopa County vector layer**
 - **GPS tracks of trails** chosen for analysis
- Attributes
 - **Total Distance** - from official trail maps
 - **1/3 arc-second DEM** - from the National Map website, which will be used for elevation gain, gradient, and altitude per segment
 - **Trail surface and obstacles per segment** - collected in the field using Collector for ArcGIS

**Categorize
Attributes**

CATEGORIZE ATTRIBUTES

- Each attribute for this project will be broken up into five categories

Altitude

Elevation Gain

Gradient

Distance

Obstacles

Trail Surface

Least Subjective

Most Subjective

CATEGORIZE ATTRIBUTES

- Each attribute for this project will be broken up into five categories
- Each category will have a ranking ranging from 1 (easiest) to 5 (hardest)

Altitude

Elevation Gain

Gradient

Distance

Obstacles

Trail Surface

Least Subjective

Most Subjective

CATEGORIZE ATTRIBUTES

- Each attribute for this project will be broken up into five categories
- Each category will have a ranking ranging from 1 (easiest) to 5 (hardest)
- The initial ranking order of each category was based on personal hiking experience and literature research

Altitude

Elevation Gain

Gradient

Distance

Obstacles

Trail Surface

Least Subjective

Most Subjective

ALTITUDE PER SEGMENT

The basis of 5 categories for the project was chosen to match a chart of oxygen levels at altitude on the Center for Wilderness web page

Altitude Breaks	Ranking
Low Altitude - 0 to 2,000 ft amsl	1 (easiest)
Medium Altitude - 3,000 to 7,000 ft amsl	2
High Altitude - 8,000 to 12,000 ft amsl	3
Very High Altitude - 13,000 to 17,000 ft amsl	4
Extreme Altitude - 18,000 to 25,000 ft amsl	5 (hardest)
Ultra Altitude - 26,000 to 29,000 ft amsl	Not Included *

* No point in North America is higher than Extreme Altitude

ELEVATION GAIN

Elevation gain ranking was based on a combination of hiking experience and literature review.

Elevation Gain Per Segment	Ranking
< 300 feet	1 (easiest)
300 to 500 feet	2
500 to 1000 feet	3
1000 to 2000 feet	4
> 2000 feet	5 (hardest)

ELEVATION GAIN

Elevation gain ranking was based on a combination of hiking experience and literature review.

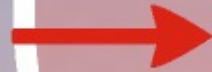
Elevation Gain Per Segment	Ranking
< 300 feet	1 (easiest)
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500 to 1000 feet	3
1000 to 2000 feet	4
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Rankings were chosen to reduce subjectivity. Any hiker would agree that as the elevation gain of a hike increases the difficulty increases.

ELEVATION GAIN

Elevation gain ranking was based on a combination of hiking experience and literature review.

Categories may be change during the field work stage of the project



Elevation Gain Per Segment	Ranking
< 300 feet	1 (easiest)
300 to 500 feet	2
500 to 1000 feet	3
1000 to 2000 feet	4
> 2000 feet	5 (hardest)

Rankings were chosen to reduce subjectivity. Any hiker would agree that as the elevation gain of a hike increases the difficulty increases.

GRADIENT

Gradient ranking was based on a literature review, which included the International Mountain Biking Association (IMBA).

Gradient per Segment	Ranking
< 5 %	1 (easiest)
Between 5 % and 10 %	2
Between 10 % and 15 %	3
Between 15 % and 20 %	4
> 20 %	5 (hardest)

Accessible trails have a gradient of less than 5%, and the IMBA does not include gradients between 15% and 20% so that was added to the ranking for this project.

GRADIENT

Gradient ranking was based on a literature review, which included the International Mountain Biking Association (IMBA).

Gradient per Segment	Ranking
< 5 %	1 (easiest)
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Between 10 % and 15 %	3
Between 15 % and 20 %	4
> 20 %	5 (hardest)

Accessible trails have a gradient of less than 5%, and the IMBA does not include gradients between 15% and 20% so that was added to the ranking for this project.

Rankings were chosen to reduce subjectivity. Any hiker would agree that as the gradient of a hike increases the difficulty increases.

TOTAL DISTANCE

Distance ranking was based on a combination of hiking experience and literature review. It was assumed that > 10 miles may be done more as a backpack trip than a day hike.

Distance (Total)	Ranking
< 3 miles	1 (easiest)
3 to 6 miles	2
6 to 8 miles	3
8 to 10 miles	4
> 10 miles	5 (hardest)

The Sierra Club ratings and personal experience influenced the categories for total distance.

TOTAL DISTANCE

Distance ranking was based on a combination of hiking experience and literature review. It was assumed that > 10 miles may be done more as a backpack trip than a day hike.

Distance (Total)	Ranking
< 3 miles	1 (easiest)
3 to 6 miles	2
6 to 8 miles	3
8 to 10 miles	4
> 10 miles	5 (hardest)

The Sierra Club ratings and personal experience influenced the categories for total distance.

Even though all hikers would agree that as distance increases difficulty increases, there would be no agreement between hikers over break points for rankings.

OBSTACLES

Obstacles ranking was based on a combination of hiking experience and literature review.

Obstacles per Segment	Ranking
None	1 (easiest)
Rocks/Steps/Obstacles < 4" high	2
Between 4" and 8" high	3
between 8" and 15" high	4
> 15" high	5 (hardest)

Maricopa County and City of Phoenix obstacles were categorized as 2", 8", and 12", while the International Mountain Biking Association and the Hiking Project (REI) classified the hardest hikes as having 15" obstacles.

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> 15" high	5 (hardest)

Maricopa County and City of Phoenix obstacles were categorized as 2", 8", and 12", while the International Mountain Biking Association and the Hiking Project (REI) classified the hardest hikes as having 15" obstacles.

Obstacles per segment will be collected in the field using Collector for ArcGIS and a tape measure.

TRAIL SURFACE

Categories in this attribute were entirely personal experience and therefore very subjective. The cobble category was created with river hiking in mind, which I feel is the most difficult even though the hike itself is flat.

Trail Surface Per Segment	Ranking
Flat and/or Paved	1 (easiest)
Mostly dirt, may include rocks and cobbles (typical AZ trail)	2
Solid Rock Trail	3
Gravel Covered Trail (up to 2.5")	4
Cobble Covered Trail (>2.5")	5 (hardest)

Trail surface is the most subjective attribute because every hiker will find something harder than someone else.

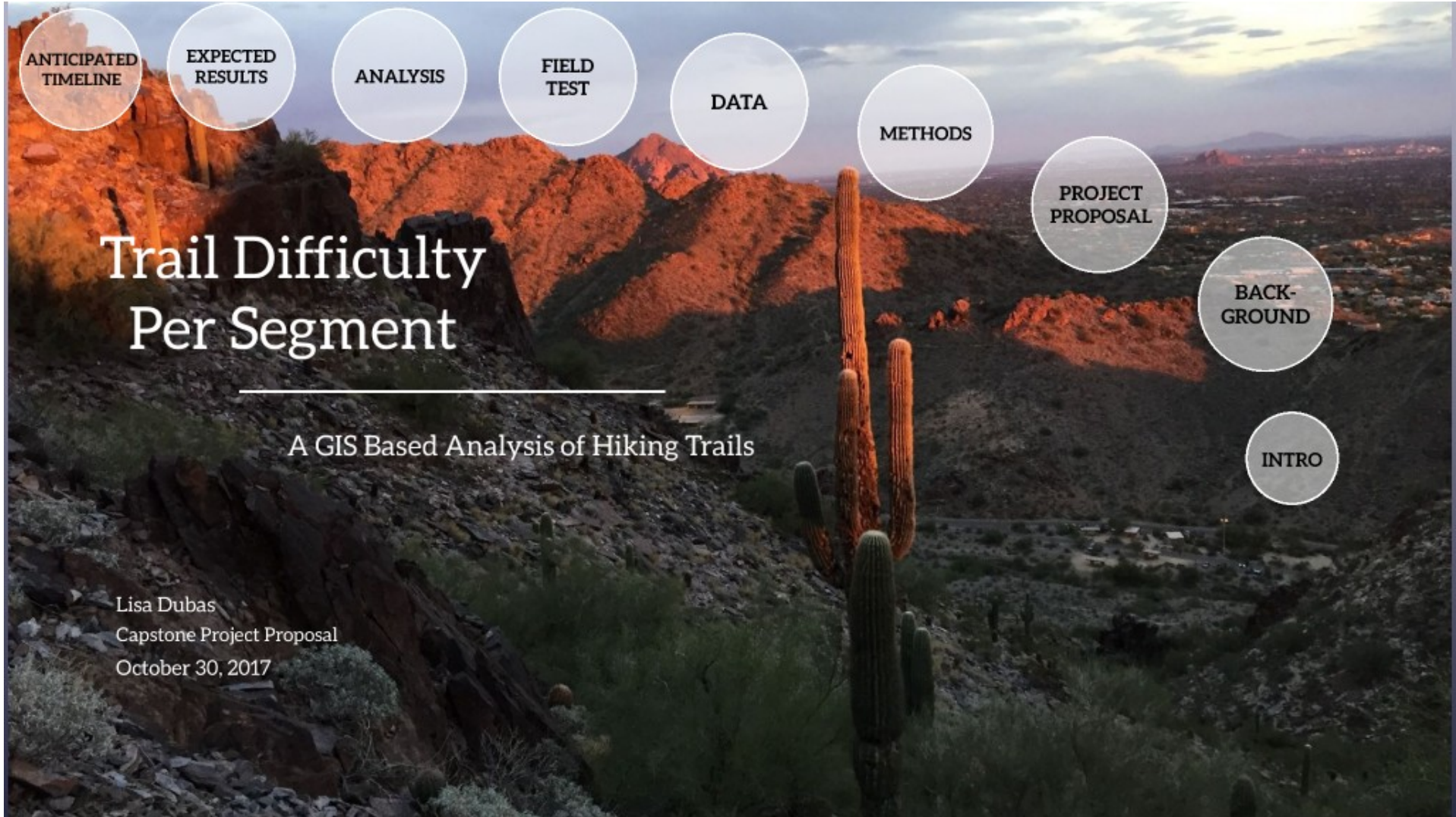
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Trail surface is the most subjective attribute because every hiker will find something harder than someone else.

Trail surface per segment will be collected in the field using Collector for ArcGIS.



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Field Test of Collector for ArcGIS App

A trial Collector for ArcGIS app was built and tested on the Gateway Loop Trail in the City of Scottsdale's McDowell Sonoran Preserve.

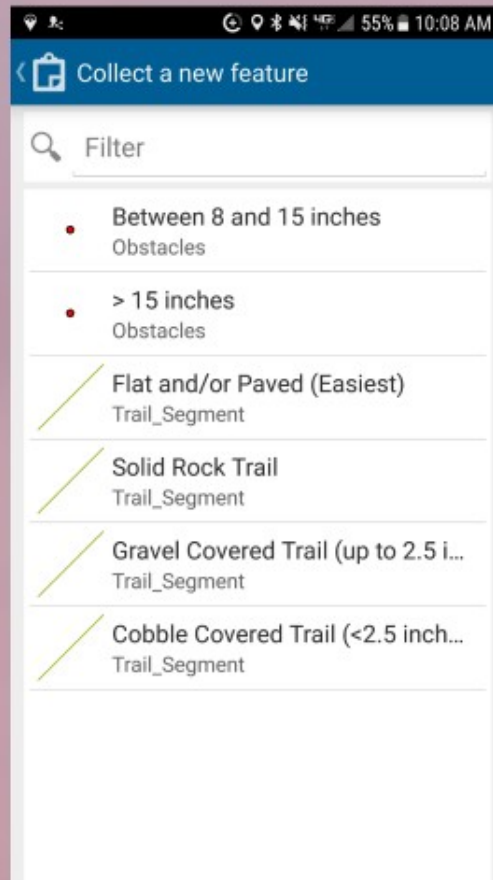
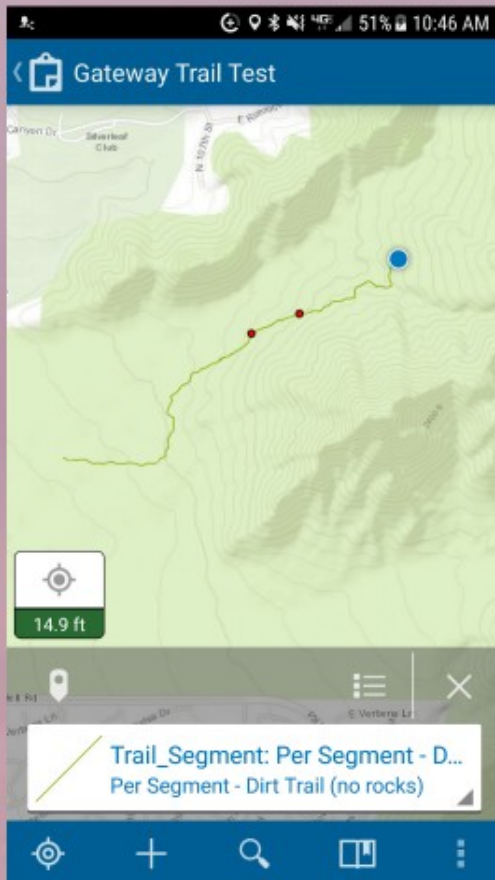
Design

Data
Entry

What I
Learned

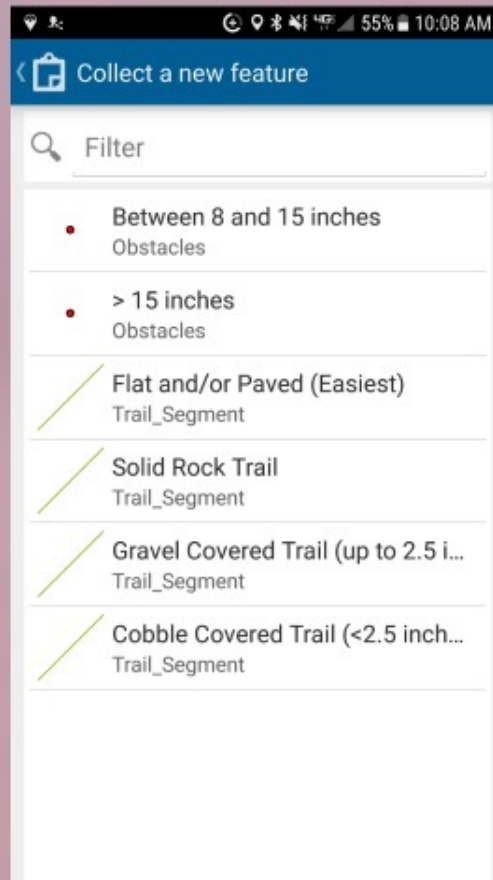
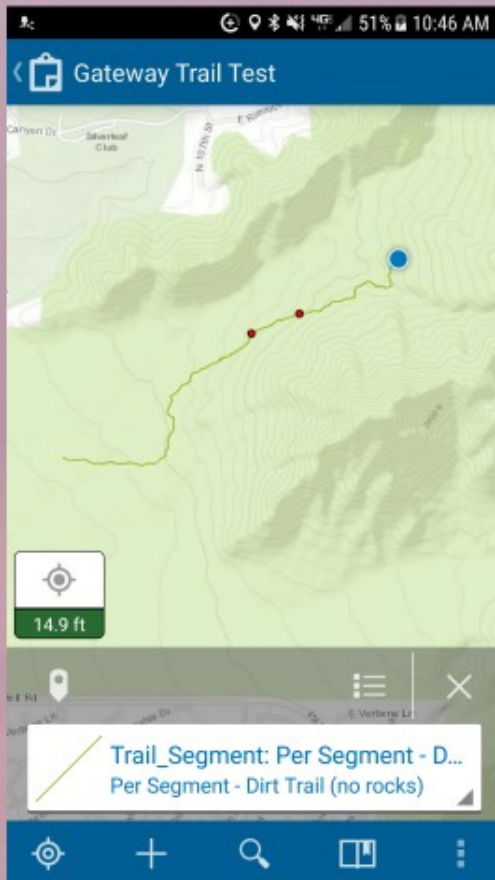
Test
Analysis

TEST COLLECTOR FOR ARCGIS APP



The test app gave the user the option to select the surface type and the obstacles encountered during the hike.

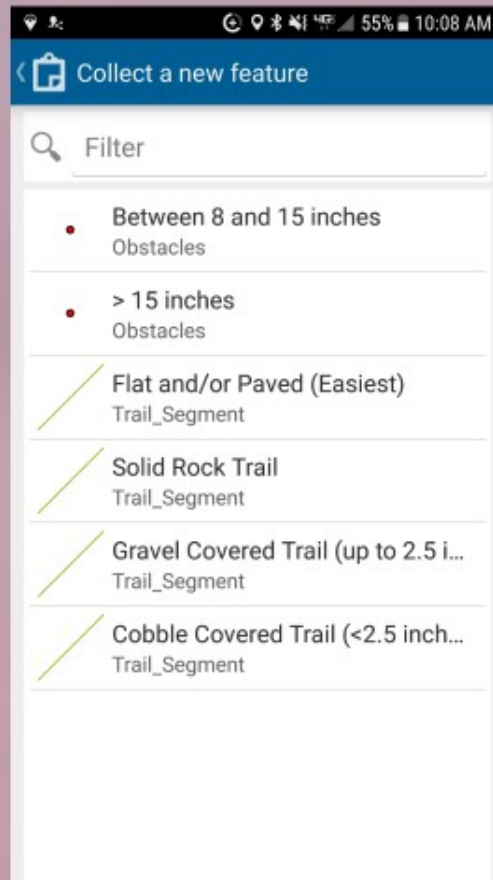
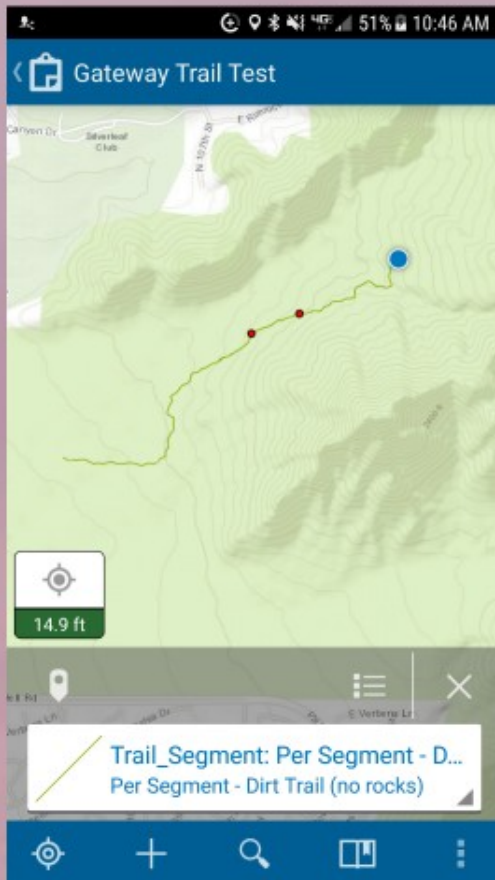
TEST COLLECTOR FOR ARCGIS APP



The test app gave the user the option to select the surface type and the obstacles encountered during the hike.

The choices for surface type and obstacles encountered were the 5 criteria for each of the two attributes.

TEST COLLECTOR FOR ARCGIS APP

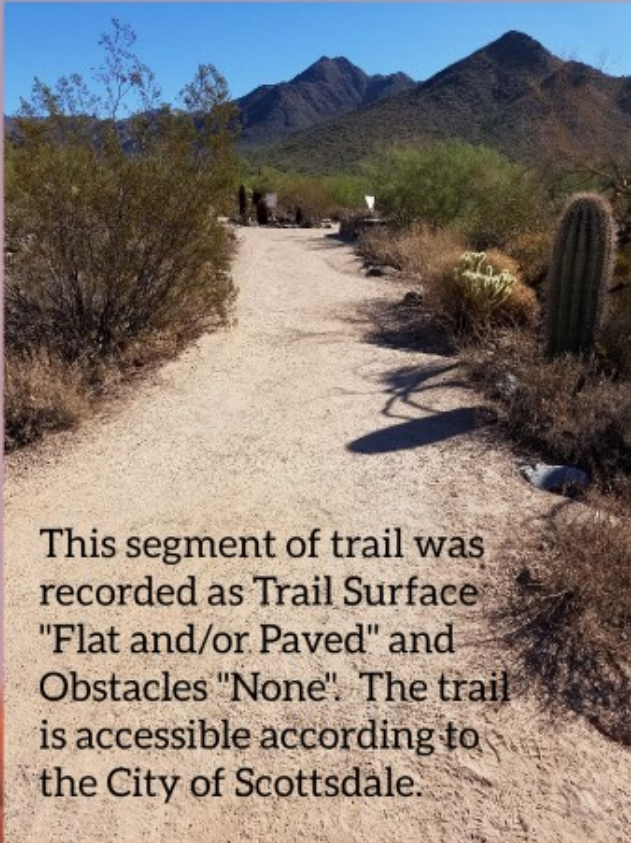


The test app gave the user the option to select the surface type and the obstacles encountered during the hike.

The choices for surface type and obstacles encountered were the 5 criteria for each of the two attributes.

The option to add points that represented obstacles between 8 and 15" and > 15" was also included for the test.

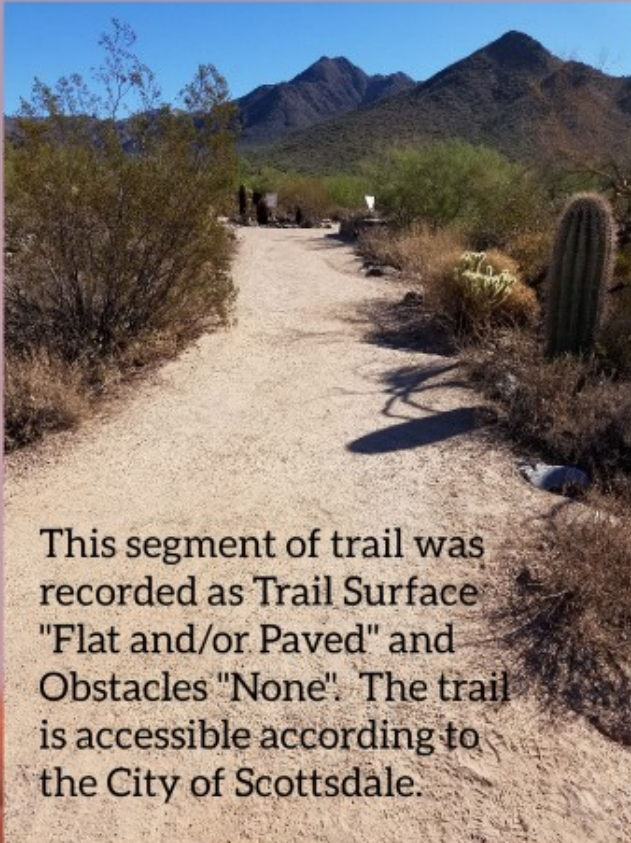
DATA ENTRY WITHIN APP



This segment of trail was recorded as Trail Surface "Flat and/or Paved" and Obstacles "None". The trail is accessible according to the City of Scottsdale.

The Collector for ArcGIS app enables a user to add, in real time, point locations, or stream a vector polyline as the person in the field walks.

DATA ENTRY WITHIN APP

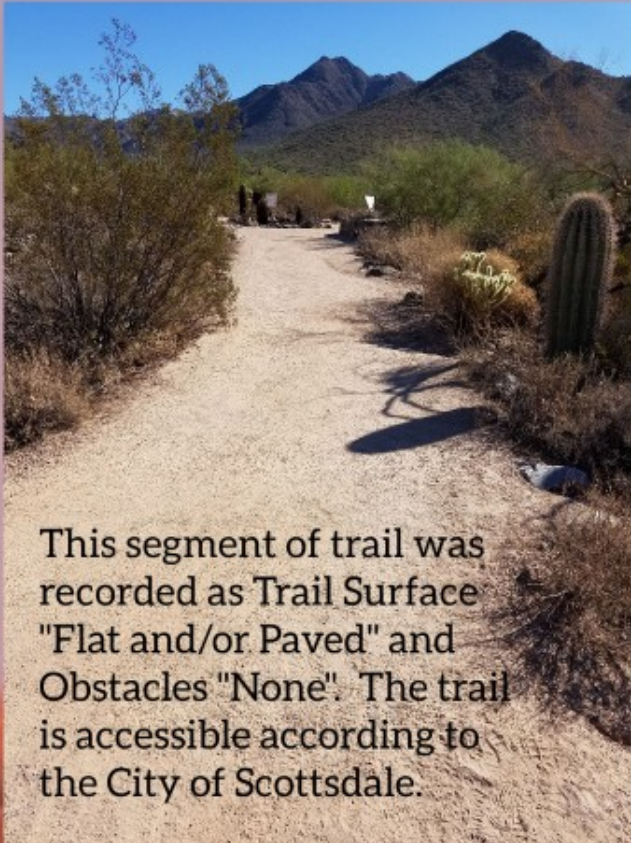


This segment of trail was recorded as Trail Surface "Flat and/or Paved" and Obstacles "None". The trail is accessible according to the City of Scottsdale.

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At the beginning of the trail I started streaming (accessible portion).

DATA ENTRY WITHIN APP



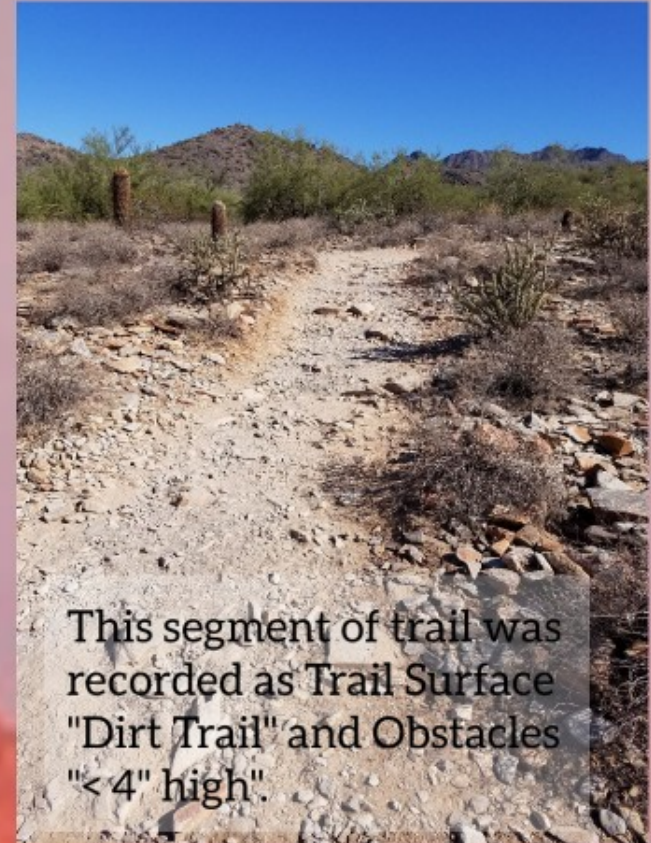
This segment of trail was recorded as Trail Surface "Flat and/or Paved" and Obstacles "None". The trail is accessible according to the City of Scottsdale.

The Collector for ArcGIS app enables a user to add, in real time, point locations, or stream a vector polyline as the person in the field walks.

At the beginning of the trail I started streaming (accessible portion).

when I reached an area where the surface and/or obstacles changed I stopped streaming that polyline (which saves the line).

The process started again on the next segment.



This segment of trail was recorded as Trail Surface "Dirt Trail" and Obstacles "< 4" high".

WHAT I LEARNED WITH THE TEST

- Initially my second category was "Dirt Trail", which I changed to "Mostly dirt, may include rocks and cobbles (typical Arizona trail)" because much of the trail was rocky, but not enough to be considered an obstacle to the hike.



WHAT I LEARNED WITH THE TEST

- Initially my second category was "Dirt Trail", which I changed to "Mostly dirt, may include rocks and cobbles (typical Arizona trail)" because much of the trail was rocky, but not enough to be considered an obstacle to the hike.
- My obstacle categories were good and only two places had an obstacle higher than 8", which I tested adding as point locations. No changes were needed to the obstacle categories I had chosen prior to the test.

WHAT I LEARNED WITH THE TEST

- Initially my second category was "Dirt Trail", which I changed to "Mostly dirt, may include rocks and cobbles (typical Arizona trail)" because much of the trail was rocky, but not enough to be considered an obstacle to the hike.
- My obstacle categories were good and only two places had an obstacle higher than 8", which I tested adding as point locations. No changes were needed to the obstacle categories I had chosen prior to the test.
- My plan had been to do the whole Gateway Loop trail during the test, but I lost reception and the app would not record data. I have since tested streaming in the offline mode and it does work. Offline downloads the dataset to your device, and when work is completed the offline dataset can be synced to the online dataset.

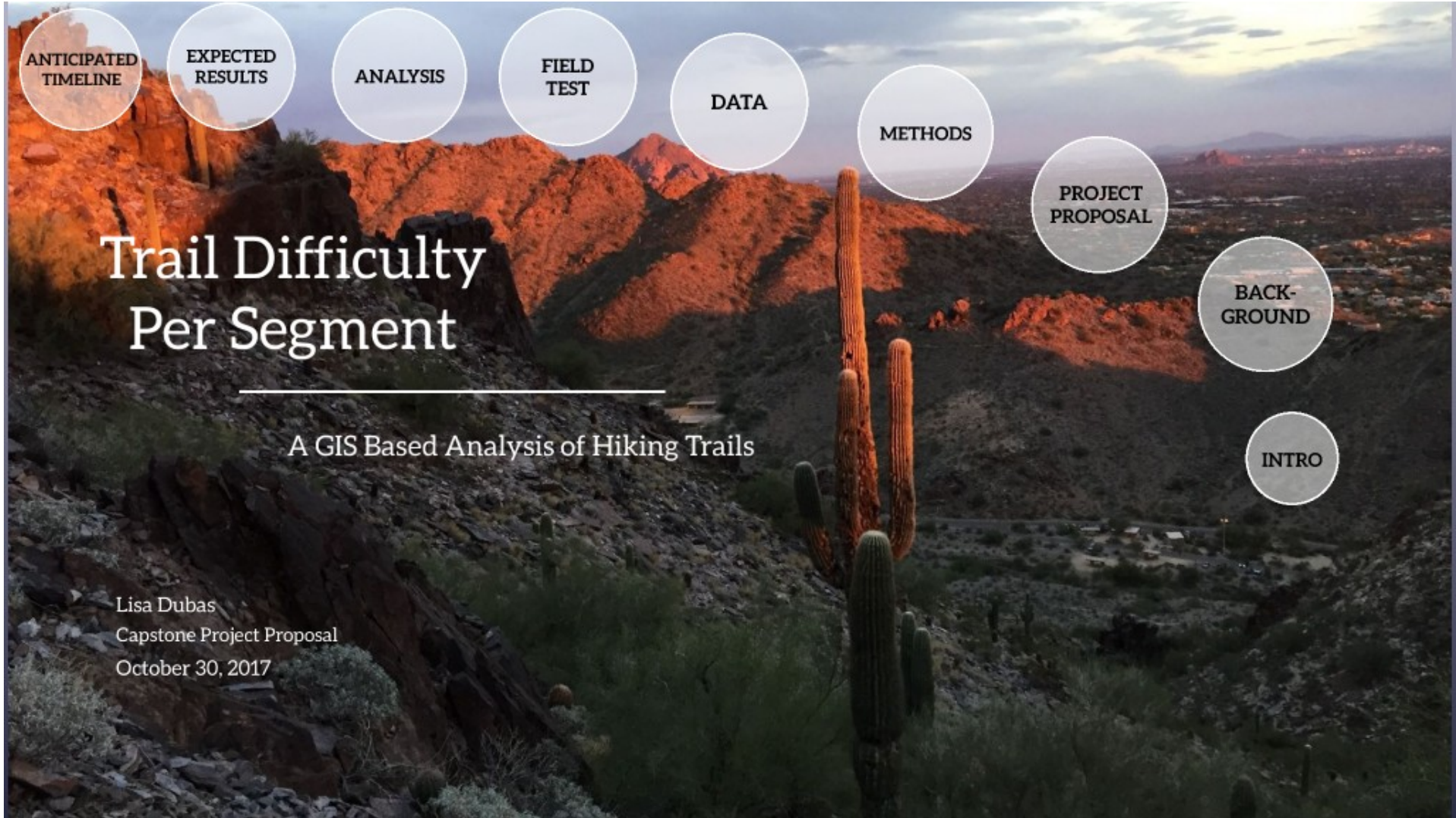
TEST ANALYSIS

Gateway Trail: McDowell Mountain Park
Difficulty Per Trail Segment Test



An analysis was done on the data in ArcGIS to investigate the assignment of data to the trail per segment.

A final process was not established, but the test indicated the analysis process would be successful in defining hiking difficulty per segment visually for hikers.



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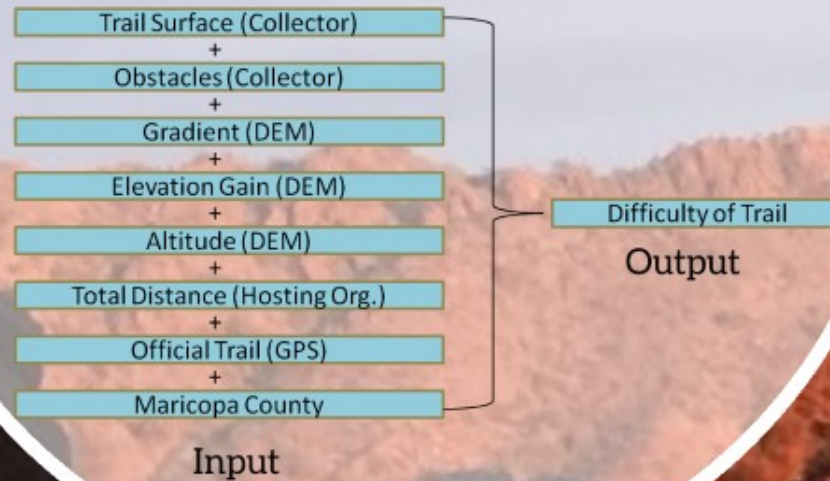
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ANALYSIS OF DATA

The weighted overlay tool in ArcMap will be used to add all of the criteria together to produce one resultant raster of difficulty per trail segment.



DEM

Field
Collected
Data

DEM AS INPUT

- The slope tool will be run on the DEM, which will calculate the maximum rate of change in percent for each cell (gradient).
- The resultant slope raster will be reclassified based on the chosen rankings for the analysis.

DEM AS INPUT

- The slope tool will be run on the DEM, which will calculate the maximum rate of change in percent for each cell (gradient).
- The resultant slope raster will be reclassified based on the chosen rankings for the analysis.
- The DEM will also be used for the change of elevation per trail segment.

DEM AS INPUT

- The slope tool will be run on the DEM, which will calculate the maximum rate of change in percent for each cell (gradient).
- The resultant slope raster will be reclassified based on the chosen rankings for the analysis.
- The DEM will also be used for the change of elevation per trail segment.
- Altitude will be derived from the DEM.

DEM AS INPUT

- The slope tool will be run on the DEM, which will calculate the maximum rate of change in percent for each cell (gradient).
- The resultant slope raster will be reclassified based on the chosen rankings for the analysis.
- The DEM will also be used for the change of elevation per trail segment.
- Altitude will be derived from the DEM.

Not sure if change in elevation per trail or change in elevation per segment will be used in the analysis but starting with per segment.



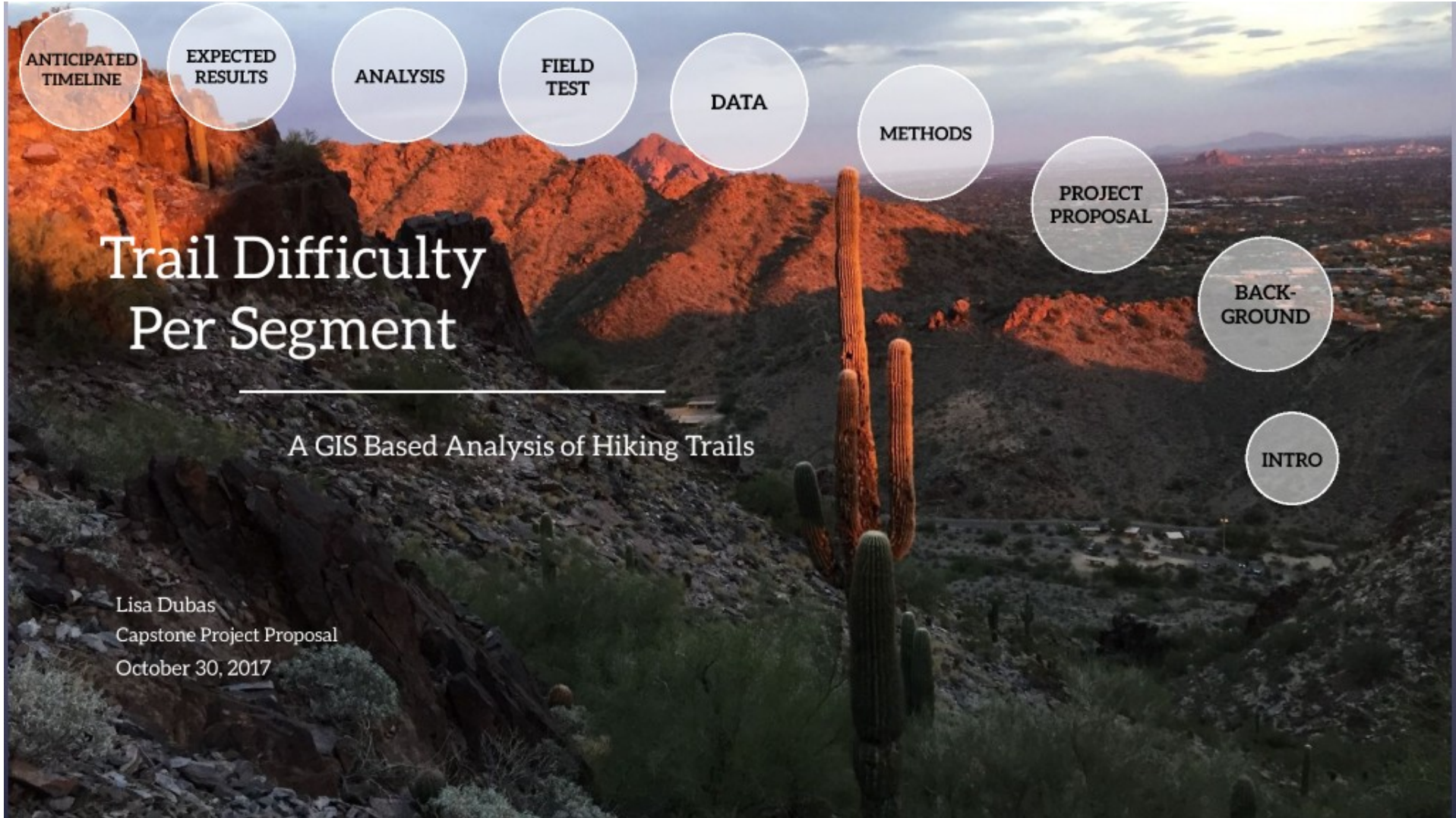
FIELD COLLECTED DATA

GPS Tracks

The GPS track data may need to be modified based on the aerial photograph. The final raster will be visualized based on the location of the GPS tracks.

Collector Data

The surface and obstacles data collected in the field will need to be reclassified based on the rankings, then the polyline data will be converted into rasters.



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EXPECTED RESULTS

- Data will be collected on at least 10 trails of varying difficulty with the Collector for ArcGIS app and a GPS throughout Maricopa County and analyzed according to the proposed attributes.

Weighting

**Online
Availability**

**Conference
Submission**

EXPECTED RESULTS

- Data will be collected on at least 10 trails of varying difficulty with the Collector for ArcGIS app and a GPS throughout Maricopa County and analyzed according to the proposed attributes.
- The test run at the Gateway Loop trail proved that trail difficulty can be established per trail segment

Weighting

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EXPECTED RESULTS

- Data will be collected on at least 10 trails of varying difficulty with the Collector for ArcGIS app and a GPS throughout Maricopa County and analyzed according to the proposed attributes.
- The test run at the Gateway Loop trail proved that trail difficulty can be established per trail segment
- A trail rating scale will be established based on the trails analyzed for the study.

Weighting

**Online
Availability**

**Conference
Submission**

WEIGHTS AND RANKING

- The field test used only the rank for the weighted overlay and did not assign weights to the criteria.

WEIGHTS AND RANKING

- The field test used only the rank for the weighted overlay and did not assign weights to the criteria.
- According to Roszkowska (2013) the rank-order centroid (ROC) method of assigning weights has a clear statistical basis and greater weights are assigned to more important criteria.

WEIGHTS AND RANKING

- The field test used only the rank for the weighted overlay and did not assign weights to the criteria.
- According to Roszkowska (2013) the rank-order centroid (ROC) method of assigning weights has a clear statistical basis and greater weights are assigned to more important criteria.
- The ROC method will be used on at least a few trails before deciding if weighting should be applied or if just using the ranks will suffice for determination of trail difficulty.

ONLINE AVAILABILITY OF RESULTS

- The data should be easily obtainable to hikers, so online alternatives for data presentation will be evaluated, including ArcGIS Online, ESRI's Story Map, and Maprika.

Maprika

**User
Submitted
Data**

ONLINE AVAILABILITY OF RESULTS

- The data should be easily obtainable to hikers, so online alternatives for data presentation will be evaluated, including ArcGIS Online, ESRI's Story Map, and Maprika.
- The goal of having the data available online is so hikers can plan ahead (maybe reroute their hike due to a section they feel is beyond their ability), or so they can anticipate what is ahead of them on the hike.

Maprika

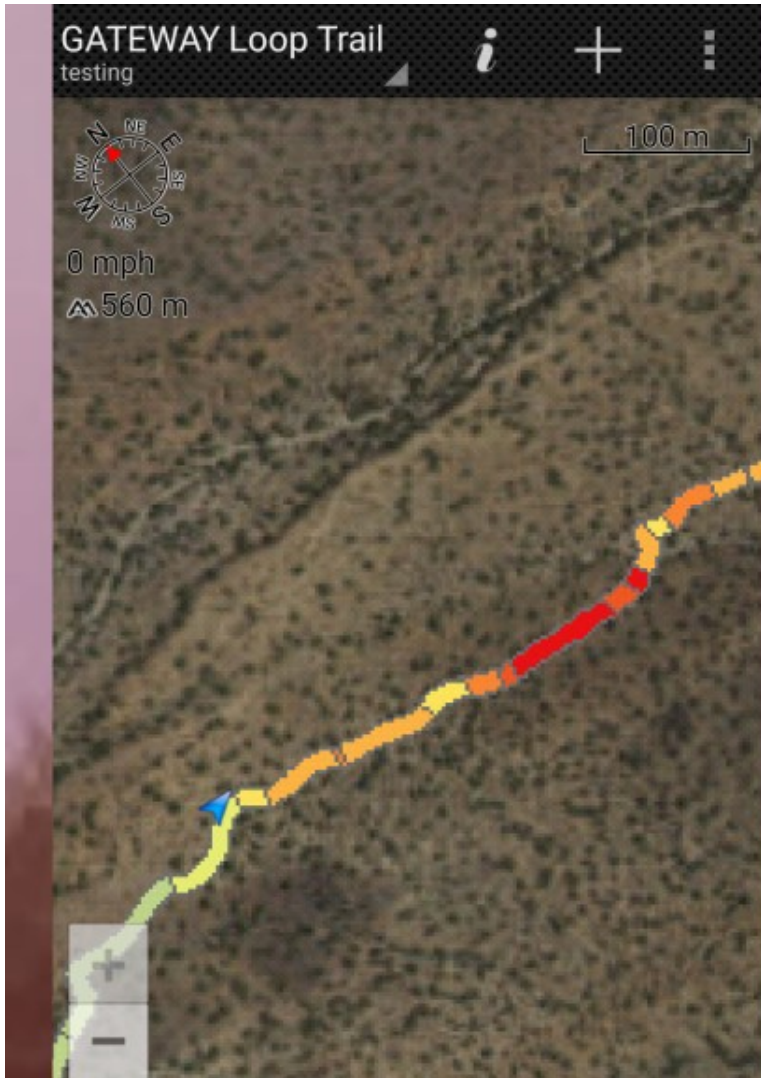
**User
Submitted
Data**

MAPRIKA

Maprika is an app for your phone that allows the user to turn any image into a GPS-enabled map.

The user uploads a photo of the map they want to use, and then through an "anchor" process (georectifying) positions that image relative to shared points on an aerial map to reproject the image into real world coordinates.









USER SUBMITTED DATA

It is unknown at this time whether functionality will be incorporated that enables a hiker to submit their own data for analysis, or whether users will be able to rank the attributes according to personal preference.

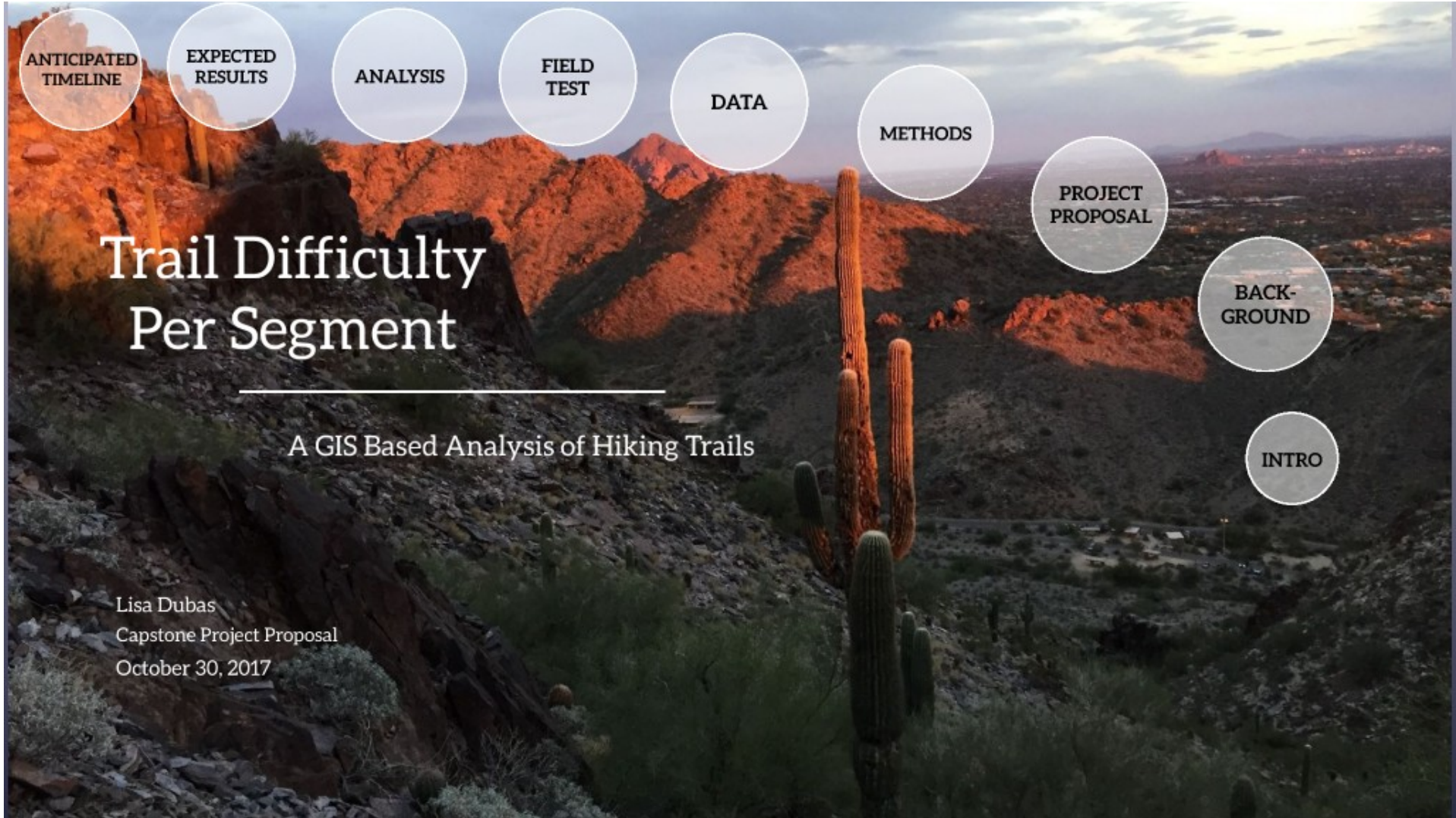
However, it is something that will be considered as the project progresses.



CONFERENCE SUBMISSION

**An abstract will be submitted for
consideration to present the results of the
project at the ESRI User Conference in San
Diego**

July 9-13, 2018



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PROJECT TIMELINE



#1: Conduct further research on trail factors and finalize Collector for ArcGIS App for field collection

#2: Collection of trail data

#3: Trail difficulty analysis and documentation

#4: Present at ESRI User Conference (San Diego)

Partial
References
List

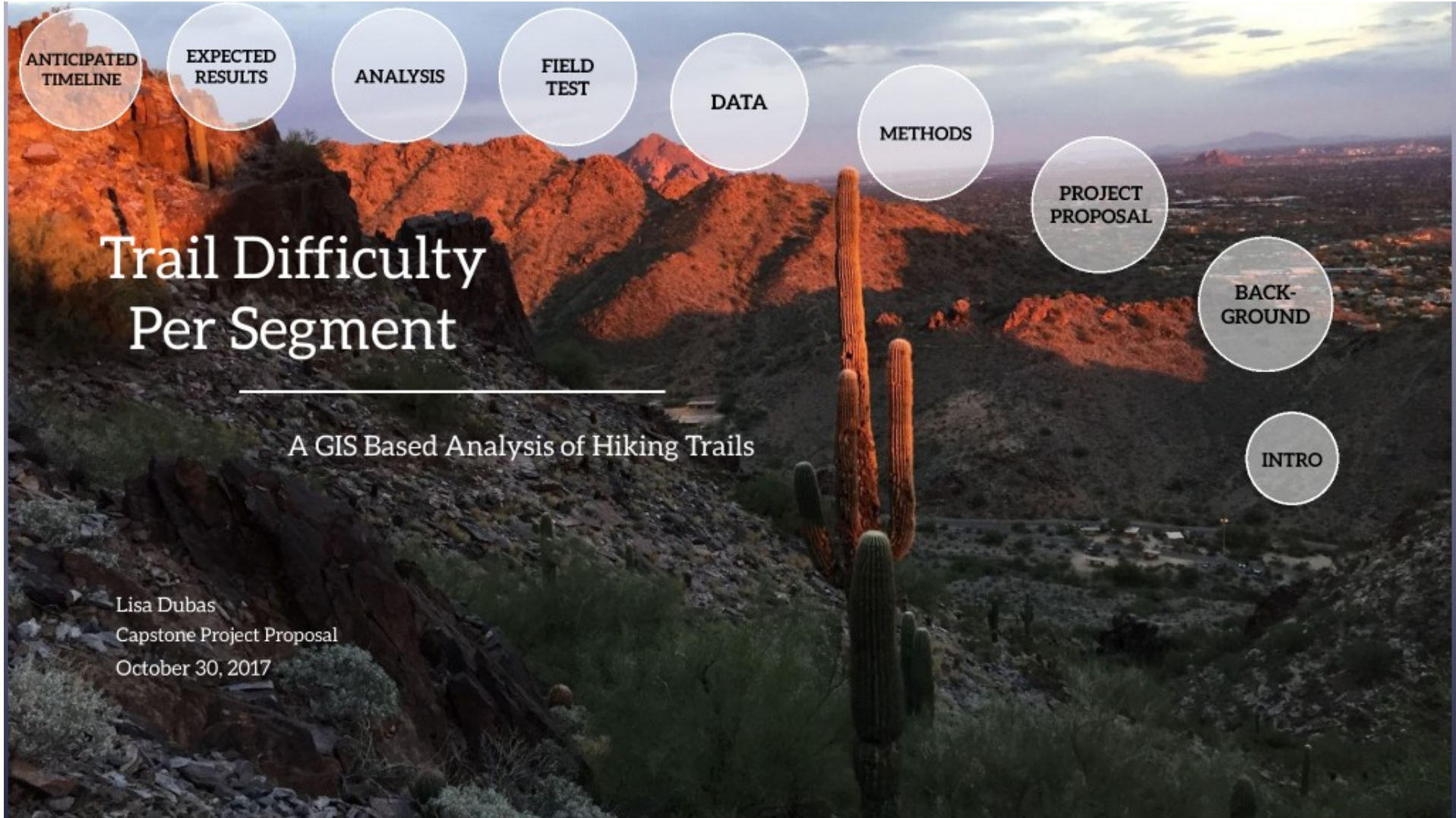
Questions
?

PARTIAL REFERENCES LIST

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A photograph of a desert canyon with red rock walls and a dirt path, with the word "QUESTIONS?" overlaid in blue text.

QUESTIONS ?



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