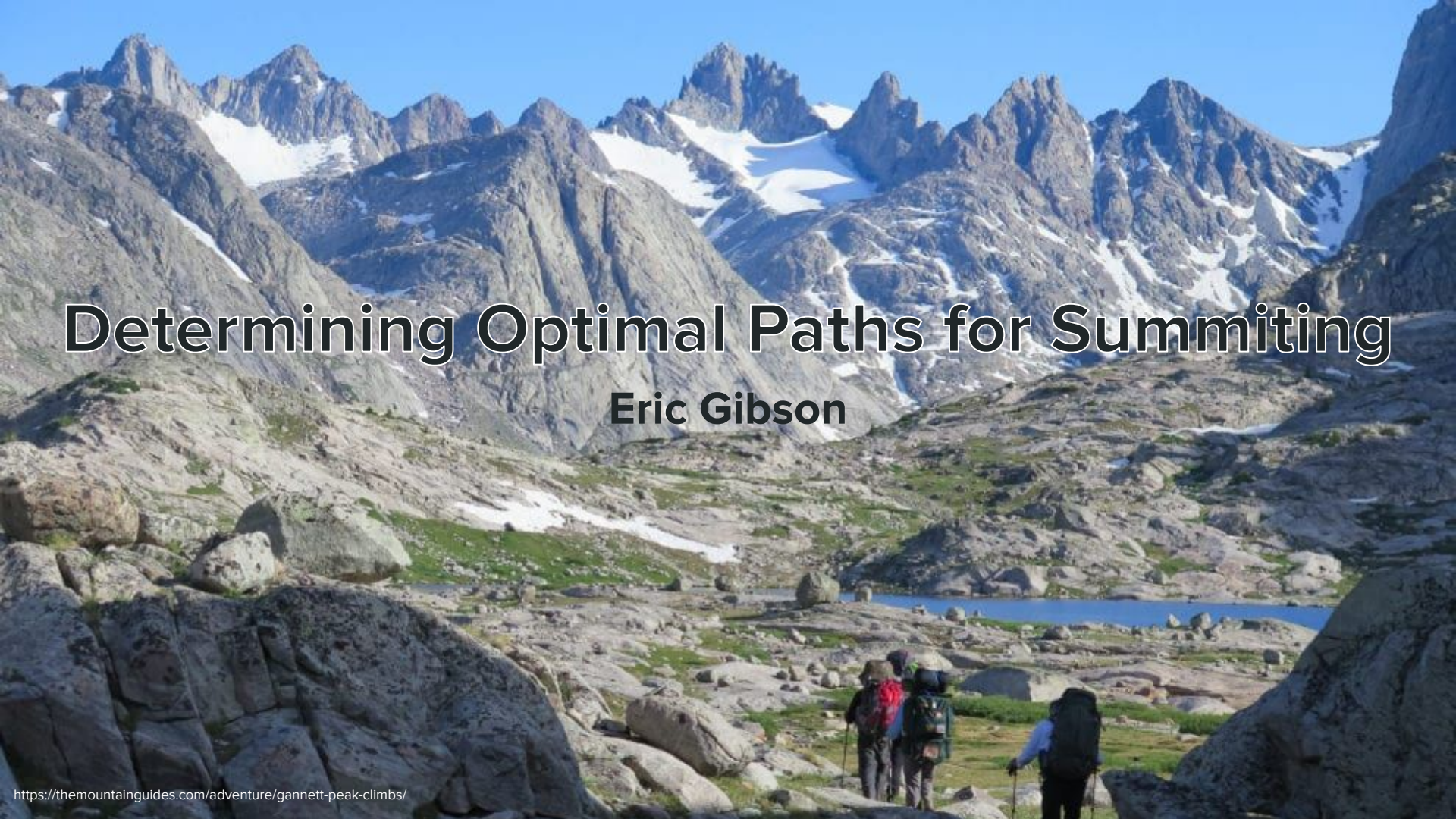
Determining Optimal Paths for Summiting

Eric Gibson



https://themountainguides.com/adventure/gannett-peak-climbs/

Abstract

Summiting is a popular activity for hikers, backpackers, and other outdoor enthusiasts. This study uses 10-meter spatial resolution digital elevation models and land cover raster datasets to determine optimal paths for summiters. The summits used within this study are peaks which cannot be reached via hiking trail, as those already have pre-determined paths for reaching the summit. Various optimal paths were created based on preferences of specific individuals as well. The paths provided helpful instruction for summiting peaks present within this study, however future analyses will be needed with more accurate and additional data.

Problem Statement

- Many high points and peaks do not have a reliable path or route to the top.
- Find a route to summit a peak based on preferences of the user.
- These routes also provide a scientific and mathematical recommendation for the highpointer as well.

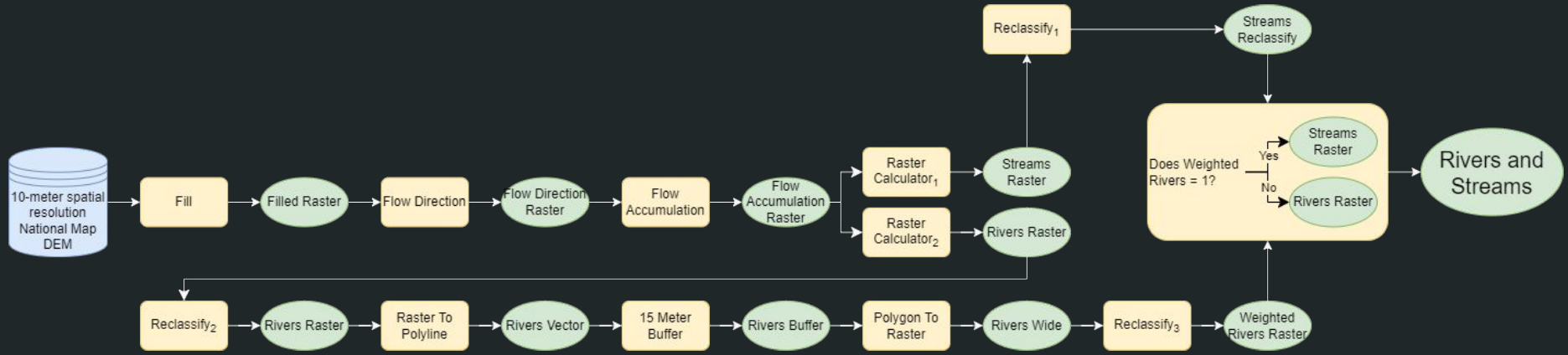
Input Data

1. Start and end points taken via the Google Places API and user input (will likely be user input). [1]

2. 10-Meter Digital Elevation Model - collected by USGS for their 3D Elevation Program (3DEP). [2]

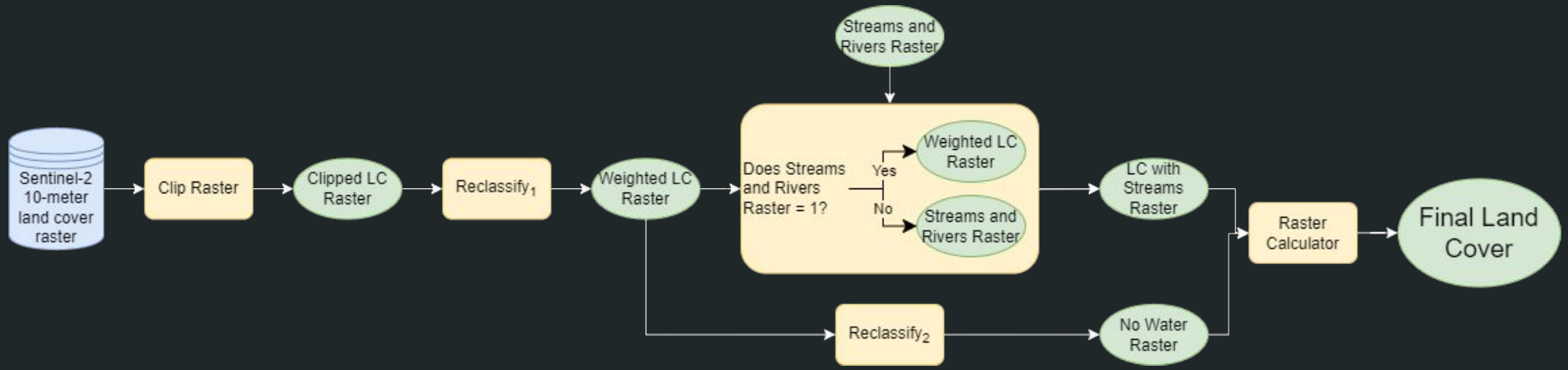
3. 10-Meter Land Cover/Land Use Dataset - collected using Sentinel-2 imagery from the ESRI Land Cover Explorer. [3]

Methods: Streams and Rivers



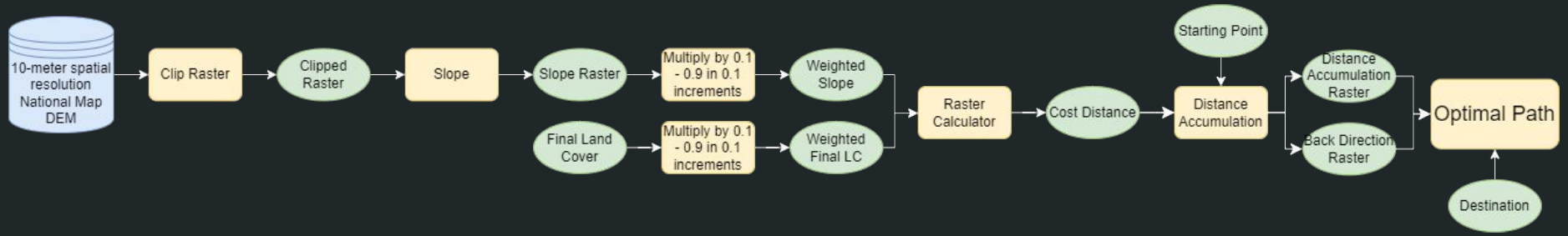
Raster Calculator$_1$: Flow Accumulation > 5000
Raster Calculator$_2$: Flow Accumulation > 500000
Reclassify$_1$: If cell = 0, then change value to 1; If cell = 1, then change value to 10
Reclassify$_2$: If cell = 0, then change value to “NODATA”
Reclassify$_3$: If cell = “NODATA”, then change value to 1; If cell = 1, then change value to 50

Methods: Land Cover



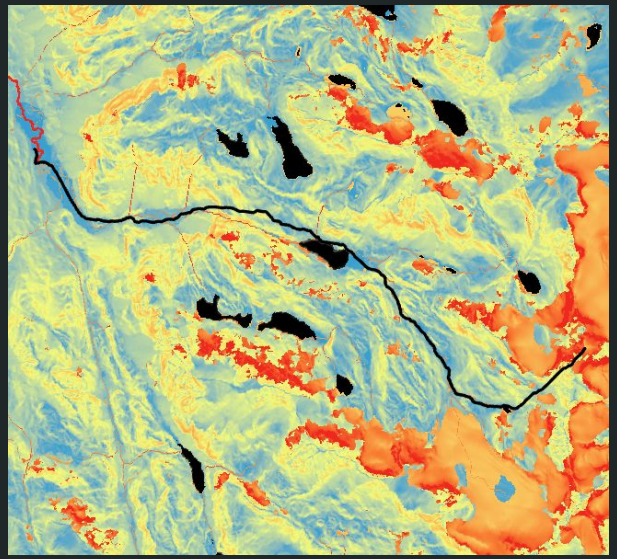
Reclassify$_1$: Keep value 2, change 4 and 5 to 3, and 9 to 8
Reclassify$_2$: All values changed to 1
Raster Calculator: LC with Streams Raster * No Water Raster

Methods: Optimal Path

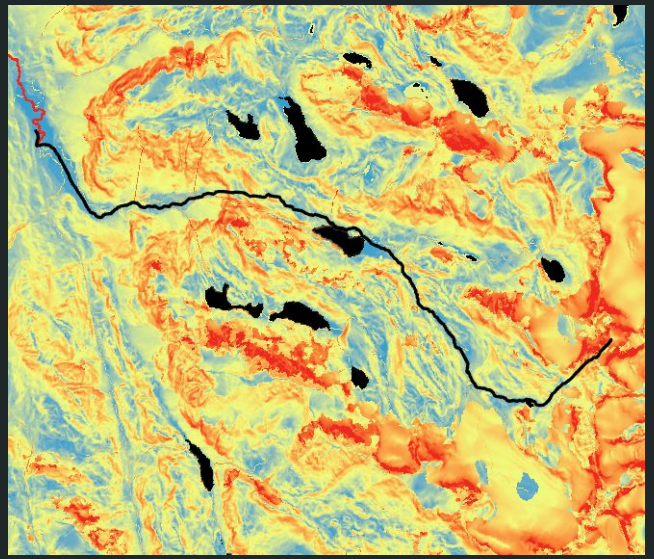


Raster Calculator: Weighted Slope * Weighted Final LC

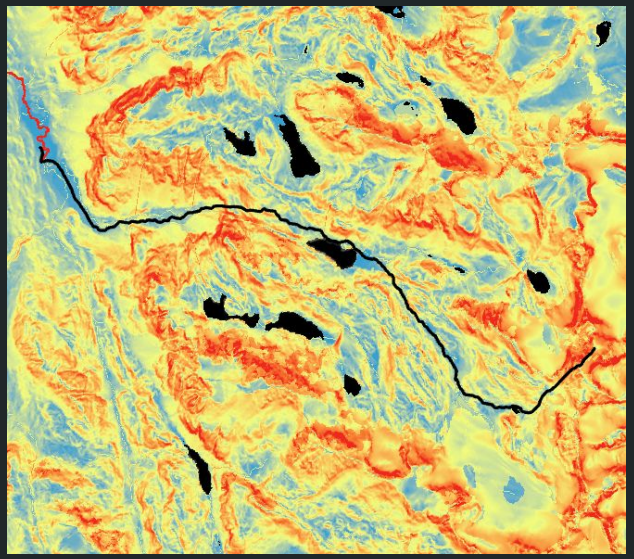
Results



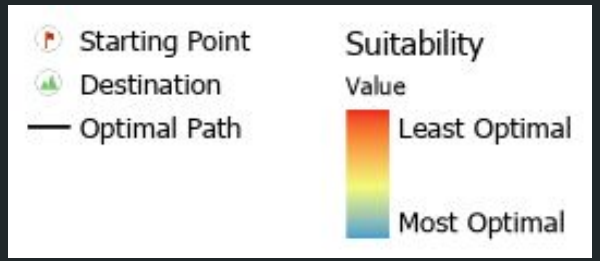
Slope: 0.1 | Land Cover: 0.9



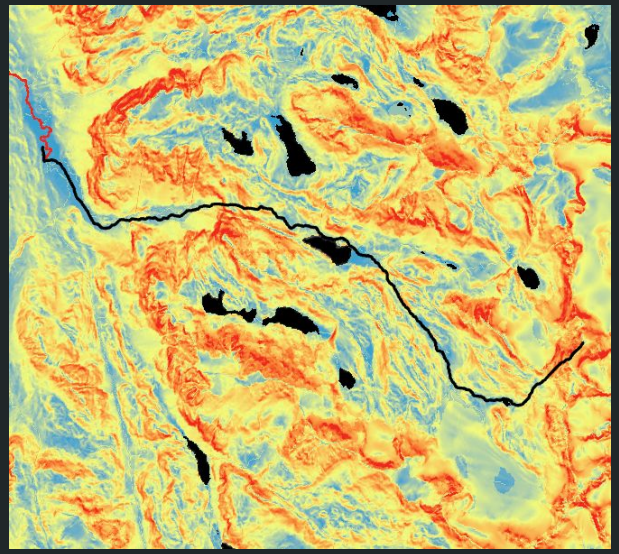
Slope: 0.2 | Land Cover: 0.8



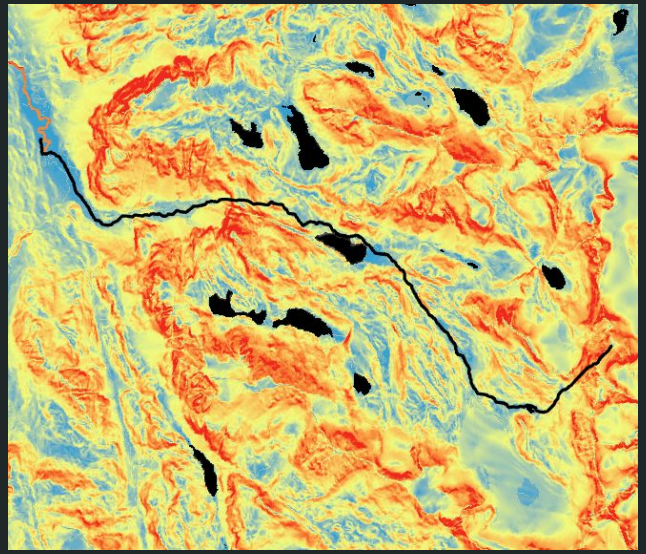
Slope: 0.3 | Land Cover: 0.7



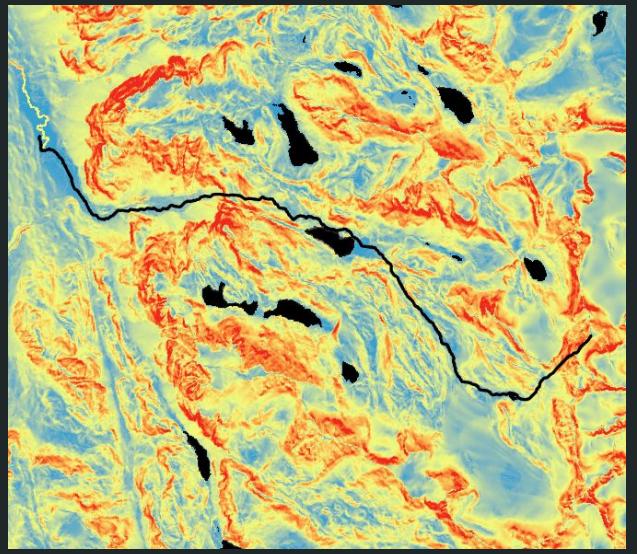
Results cont.



Slope: 0.4 | Land Cover: 0.6

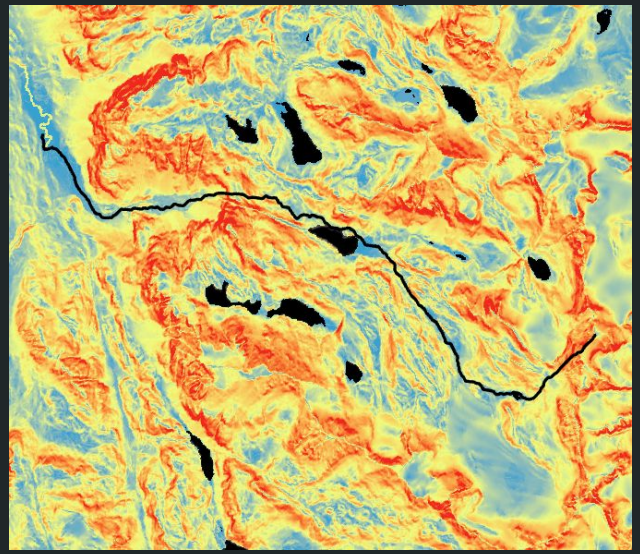


Slope: 0.5 | Land Cover: 0.5

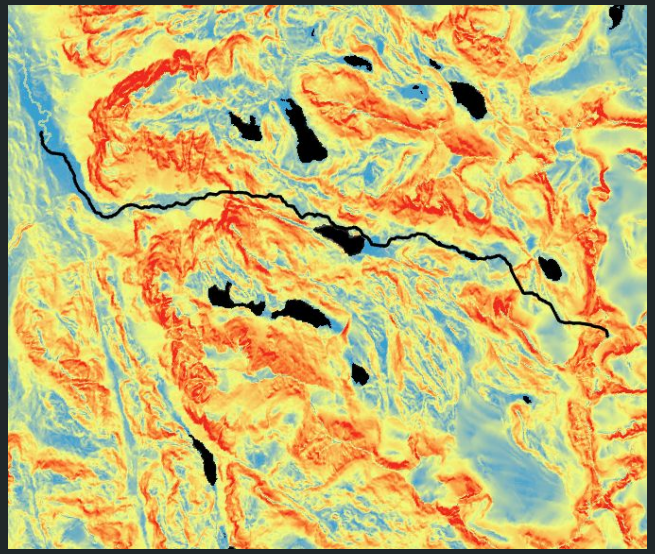


Slope: 0.6 | Land Cover: 0.4

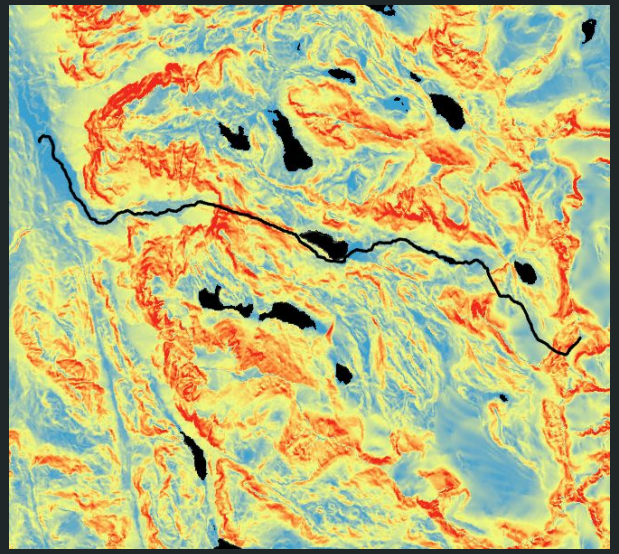
Results cont.



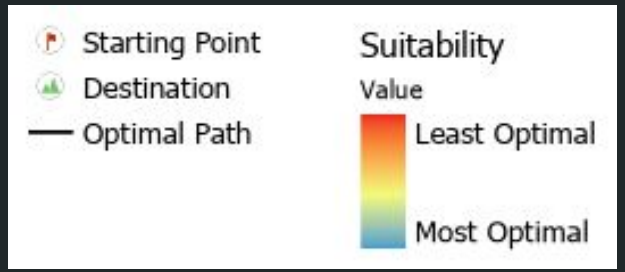
Slope: 0.7 | Land Cover: 0.3



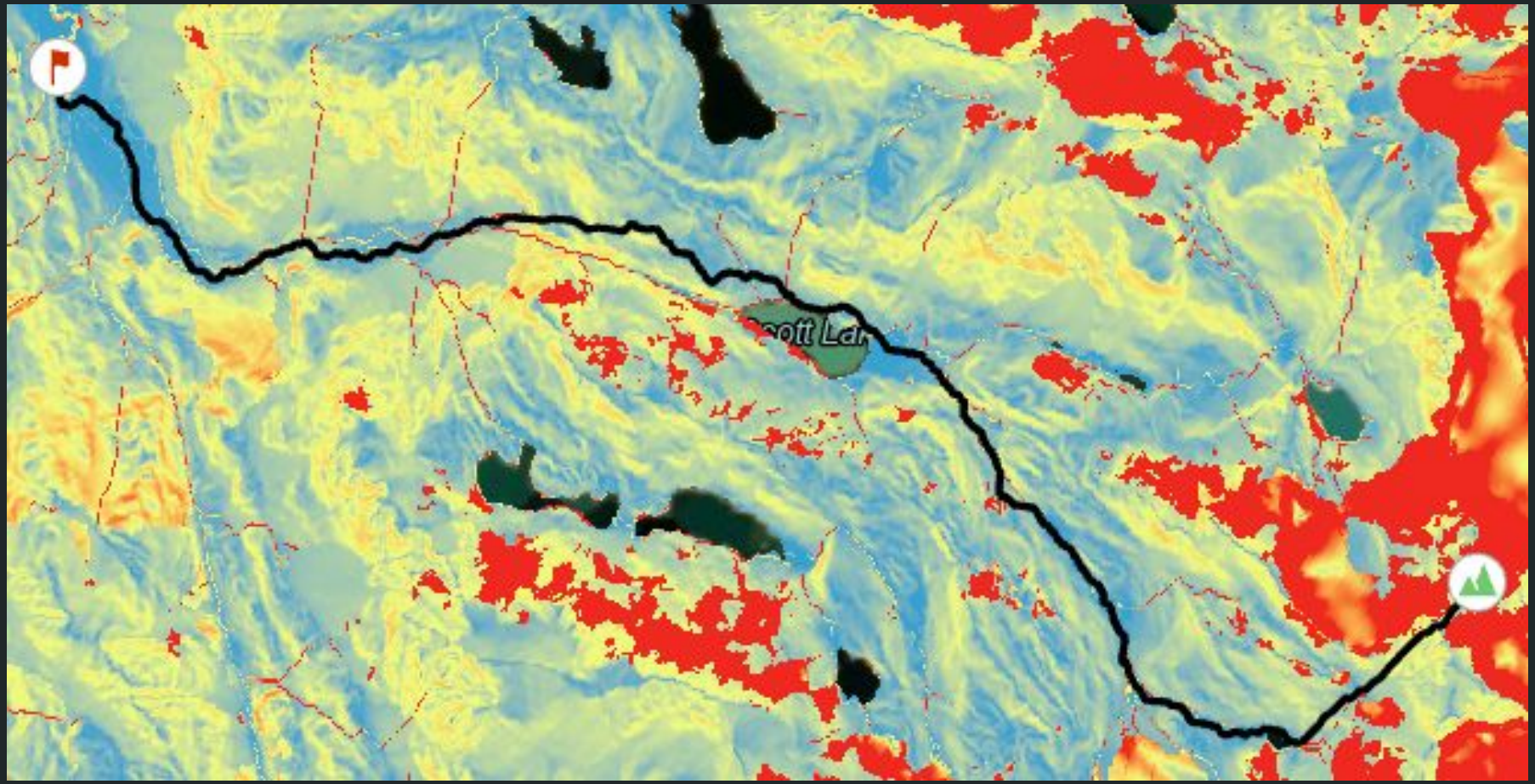
Slope: 0.8 | Land Cover: 0.2



Slope: 0.9 | Land Cover: 0.1

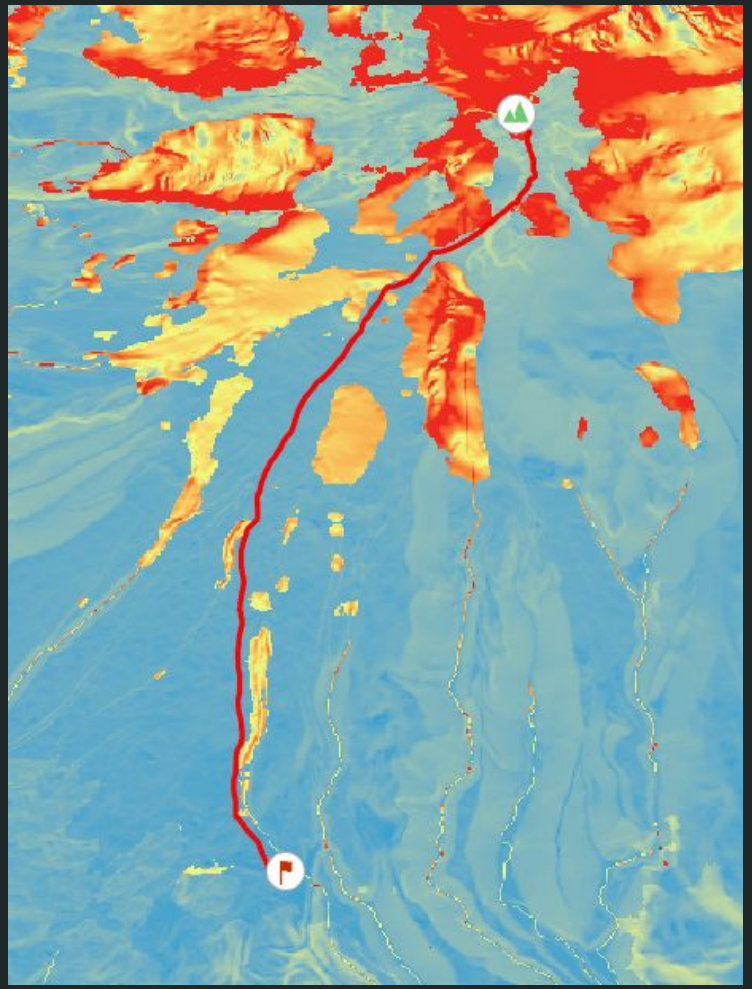


Results cont.



Results cont.

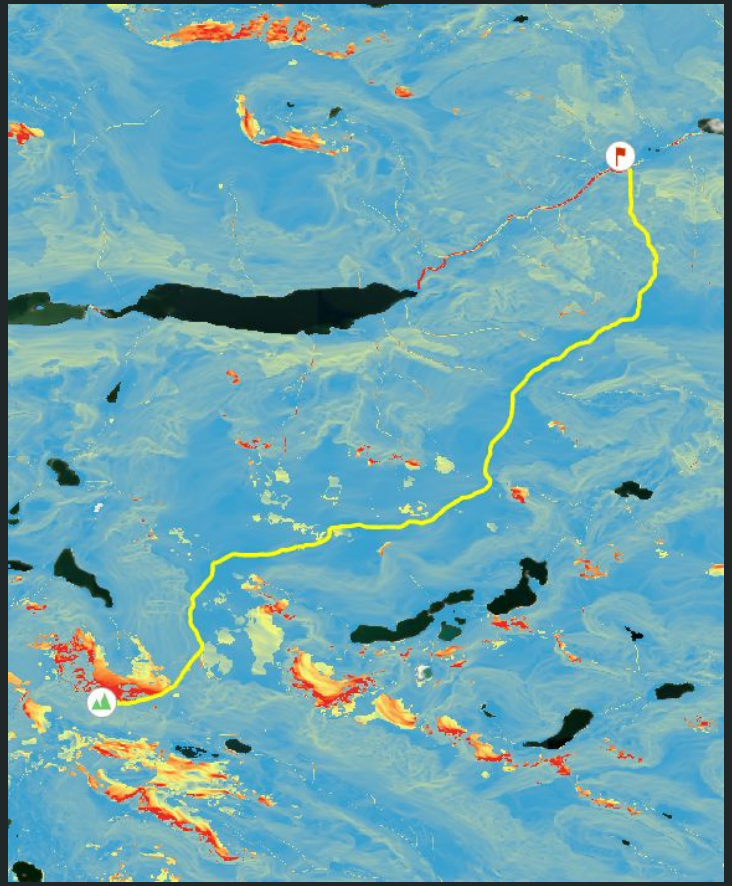
Results cont.



Starting Point
Destination
Optimal Path

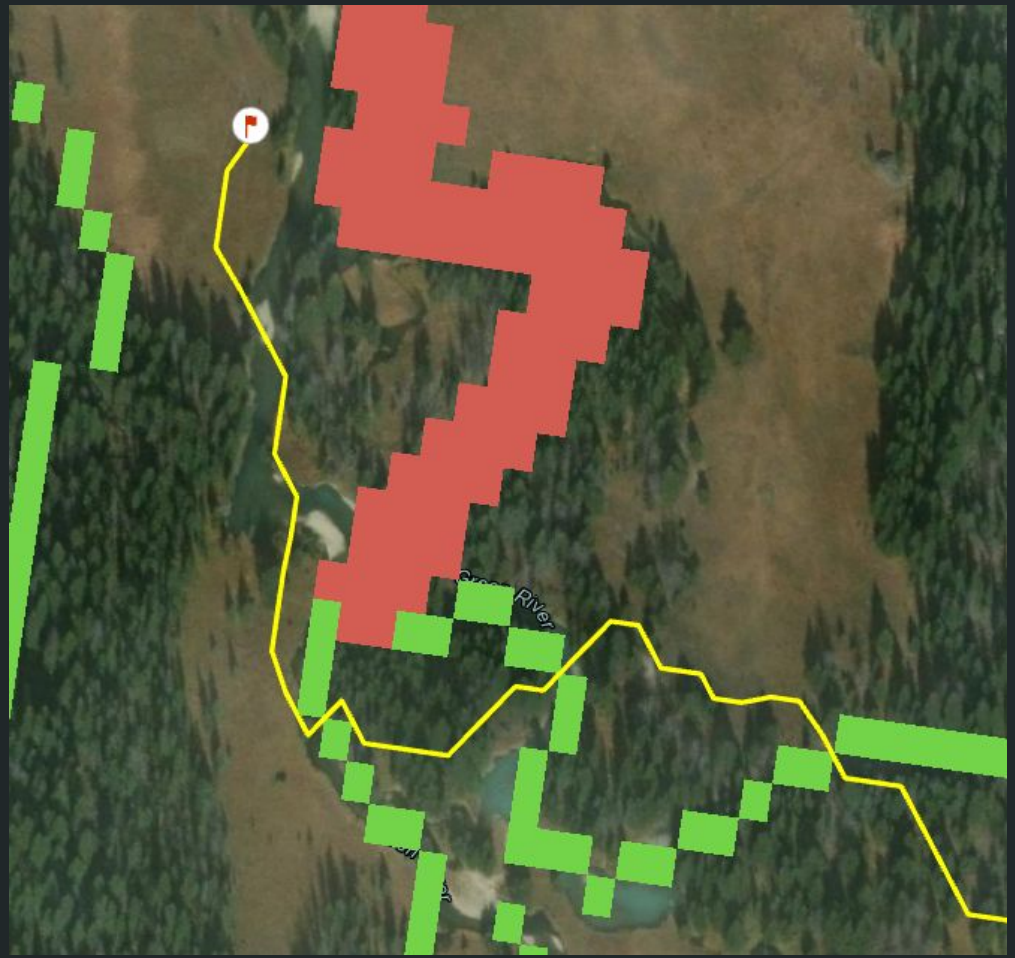
Suitability
Value
Least Optimal
Most Optimal

Results cont.



Results cont.

Results cont.



Verification

Verifications were done simply by comparing the output optimal paths determined by my model with the routes drawn and traveled by avid hikers and highpointers [4]. Quantitative verification needs to be implemented.

https://fastestknowntime.com/route/gannett-peak-wy#:~:text=and%20tough%20climbing.-,Most%20often%2C%20Gannett%20is%20approached%20from%20the%20south%20via%20the,summit%20day%20for%20most%20parties.

Verification cont.

Many descriptions of the best path are available online through sites like SummitPost.org. Both Mount Hood and Granite Peak had areas where the route matched and did not match. [5] [6]

Mount Hood:

- Matched: Keep right of ski slopes at beginning of route
- Unmatched: Stay left of Steel Cliffs and move over snow patches

Granite Peak:

- Matched: End of route once the saddle between Tempest Mountain and Granite Peak is reached
- Unmatched: Route along Mystic Lake - should add in trail data

Discussion and Conclusion

- Provides helpful information for initially beginning a route for summiting.
- Can reliably and successfully avoid land cover types not optimal for traversing.
- The optimal paths created for differing preferences were similar except for the ones most favoring land cover.
- Some manual manipulation or more accurate data may be required for future analysis
- Trail data should be added along with weights based on input from professionals

References

[1] Chu, Justin. “Overview.” *Google*, developers.google.com/maps/documentation/places/web-service/overview. Accessed 09 Oct. 2023.

[2] United States Geological Survey. *National Map*, 1/3 Arc Second Digital Elevation Model, 2022, Accessed 6 Nov. 2022.

[3] ESRI. “Esri | Sentinel-2 Land Cover Explorer.” *Sentinel-2*, Land Use Land Cover, 2022, Accessed 6 Nov. 2022.

[4] Redwic. “Gannett Peak.” *SummitPost.Org*, www.summitpost.org/gannett-peak/150362. Accessed 13 Nov. 2023.

[5] John. “Mount Hood.” *SummitPost.Org*, www.summitpost.org/mount-hood/150189. Accessed 13 Nov. 2023.

[6] Lemke, Matt. “Granite Peak.” *SummitPost.Org*, www.summitpost.org/granite-peak/150239. Accessed 13 Nov. 2023.

ESRI. “ArcGIS pro Geoprocessing Tool Reference.” *ArcGIS Pro Geoprocessing Tool Reference-ArcGIS Pro | Documentation*, 2023, pro.arcgis.com/en/pro-app/latest/tool-reference/main/arcgis-pro-tool-reference.htm.