DEVELOPING TOOLS FOR OVERFLIGHT ANALYSIS IN NATIONAL PARKS USING GIS

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CONTENTS

BACKGROUND

Problem Statement:

The NSNSD must be able to monitor air tour overflights for compliance with Air Tour Management Policies and other legal requirements.

Great Smoky Mountains NP ATMP:

- Three primary rules:
  1) 1 mile from historic points of interest and cultural districts
  2) ½ mile from Appalachian Trail
  3) Minimum altitude of 2,600ft above ground level (AGL)

*Study area is GRSM but methods can be adapted for other parks

PROJECT OBJECTIVES

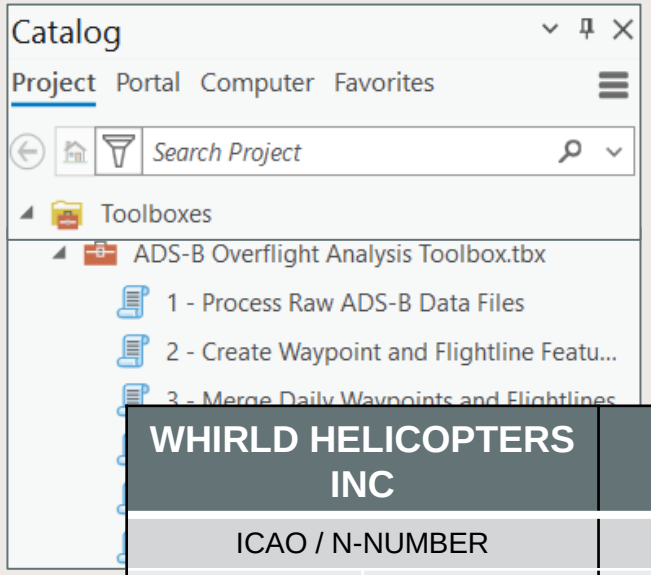
1. Establish methods for detecting ATMP non-compliance; use ArcGIS Pro ModelBuilder to create models that can be automated or integrated into ADS-B Overflight Analysis Toolbox.
2. Analyze ADS-B data logger viewsheds for blind spots; use ArcGIS Pro 3D analysis tools.

This project utilized ADS-B data collected from the NSNSD ADS-B data loggers, but the methods can easily be adapted for operator provided data.

METHODS

DATA AND PREPROCESSING

ADS-B Overflight Analysis Toolbox



Filtered by Operator

WHIRLD HELICOPTERS INC		ROTORPRO LLC	
ICAO / N-NUMBER		ICAO / N-NUMBER	
A10977	166RH	A1DC89	219SH
A1A96E	206MP	A4E838	415RP
A480B0	39CP	A71289	555FP
A54798	4395D	A7525B	571CJ
A54EA4	441DE		
AA48A1	7617W		
AB4F00	828EJ		

	ADS-B Data
Source	National Park Service
Collection Method	Terrestrial data loggers (ADS-B receiver)
Format	Tabular data
File type	.tsv
Attributes	Identification (ICAO), location, altitude, velocity, timestamp
Limitations	ADS-B data is only available for days where data loggers were active.

- 10m National Elevation Data (NED)
- All park data sourced from USGS

IDENTIFYING ATMP NON-COMPLIANCE

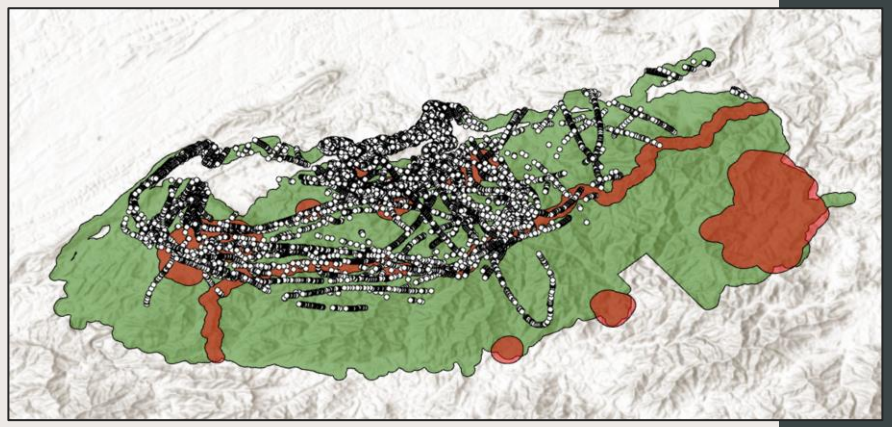
Objective:

- Identify air tour flights that violate the three primary rules from the GRSM ATMP
  - Stay 1 mile from POIs and historic districts
  - Stay ½ mile from AT
  - Fly above 2,600ft AGL

Process:

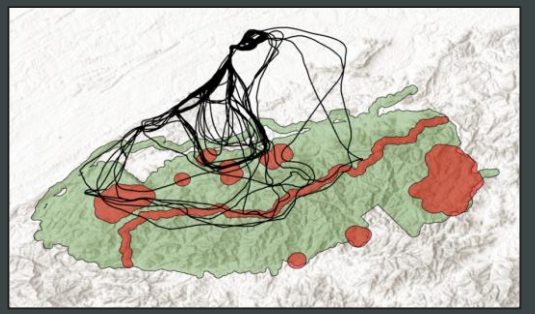
- Preprocess ADS-B data
- Build models to capture methods for identifying non-compliant air tours
- Verify model

NON-COMPLIANCE MODELS



Overview

- 5 primary models
  - NFZ non-comp. (point data)
  - Minimum altitude non-comp.
  - Create flight table
  - Populate compliance attribute
  - Join attribute to dataset
- 1 auxiliary model
  - NFZ non-compliance (line data)



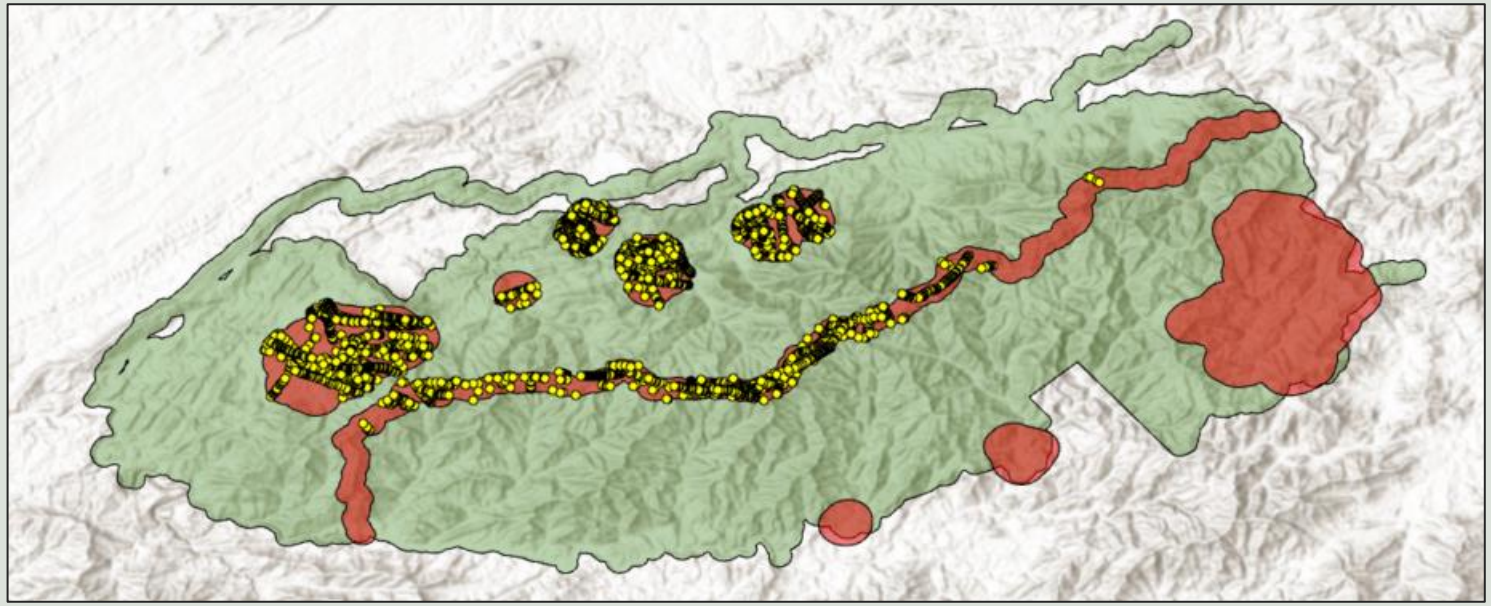
Data required:

ADS-B point data, GRSM park boundary (with ½ mile buffer), and the NFZ shapefile

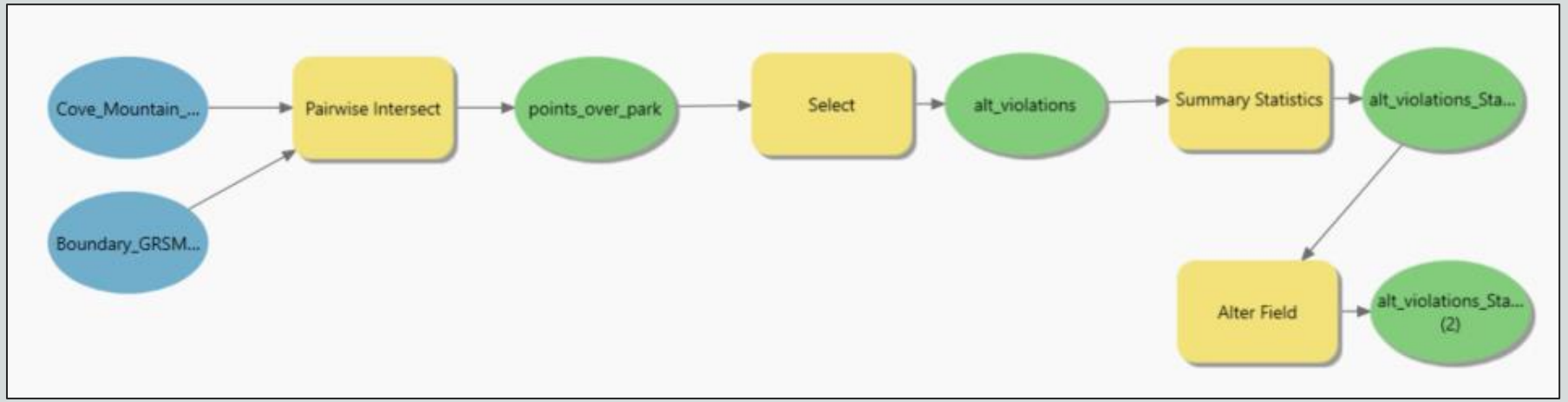
NO-FLY ZONE NON-COMPLIANCE

Total Points	NFZ Non-Comp.
36,053	6,804

- Original operator routes were flying over several areas of interest over the park
- Non-compliant flights will decrease with implementation of new routes

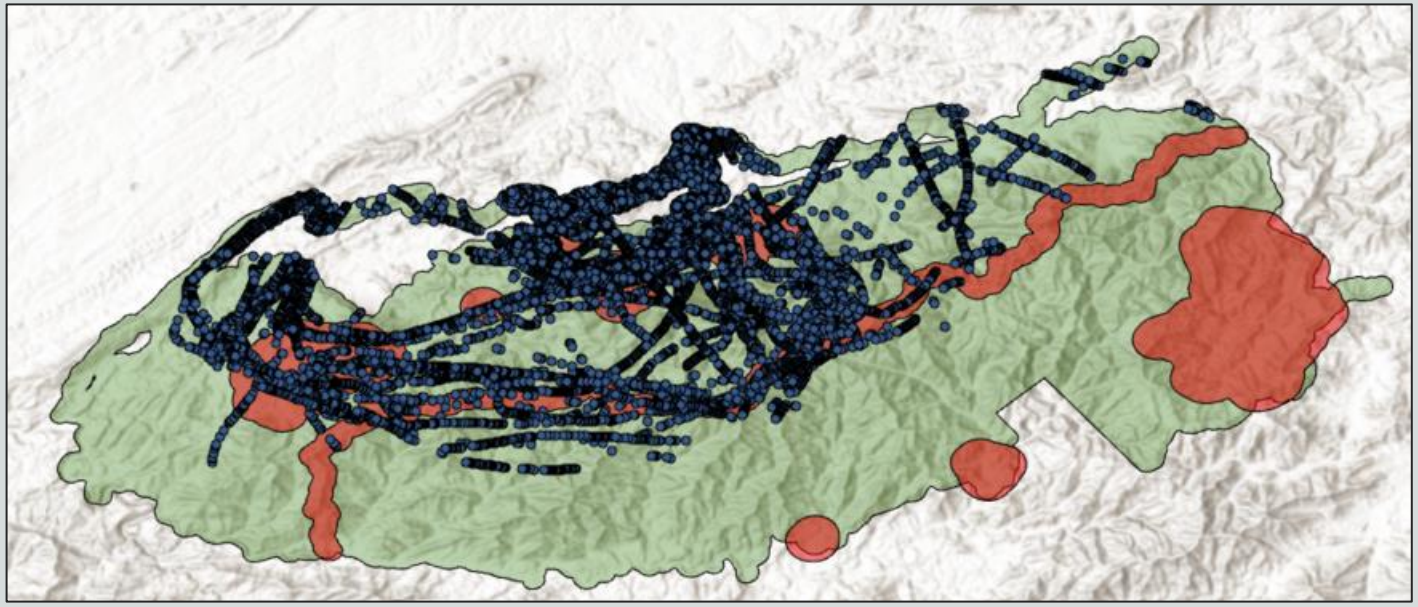


ALTITUDE NON-COMPLIANCE

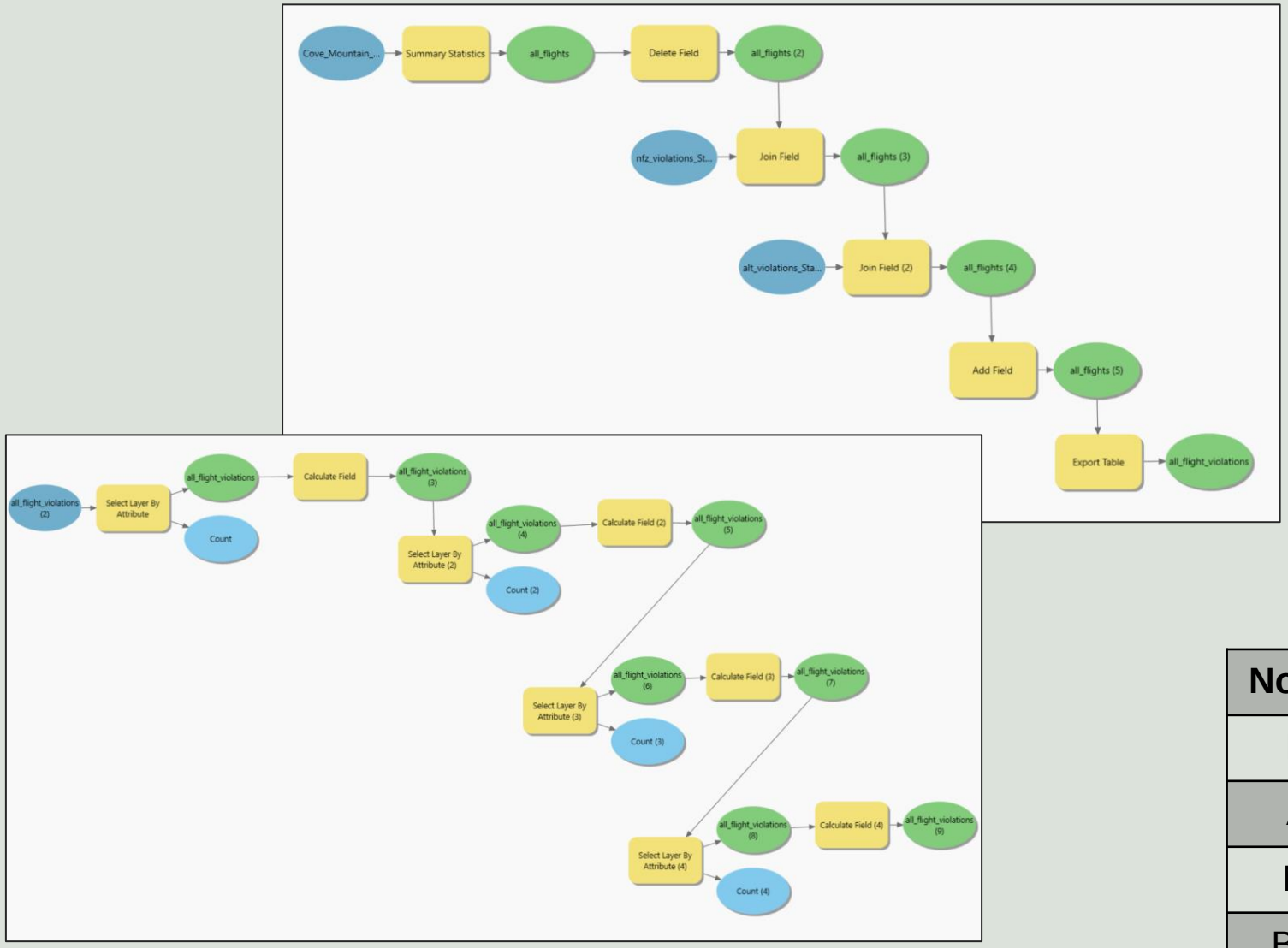


Total Points	ALT Non-Comp.
36,053	35,785

- This model shows results using the ADS-B data attribute “altitude”
- Operators have admitted that they are have been flying between 1,000ft AGL and 1,500ft AGL on average (before ATMP implementation)



ALL FLIGHT NON-COMPLIANCE



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5	5	A10977_0_20220423	A10977_0_20220423	A10977_0_20220423	3
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15	15	A10977_0_20220525	A10977_0_20220525	A10977_0_20220525	3
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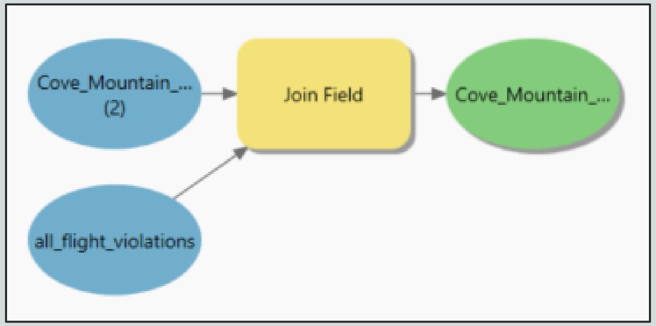
18	18	A10977_0_20220529	A10977_0_20220529	A10977_0_20220529	3
19	19	A10977_0_20220530	<Null>	A10977_0_20220530	1
20	20	A10977_0_20220604	A10977_0_20220604	A10977_0_20220604	3

Non-Comp. Type	Attribute Value
No Violations	0
ALT Violation	1
NFZ Violation	2
Both Violations	3

ADD NON-COMPLIANCE ATTRIBUTE TO DATASET



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20221125	A10977_0_20221125	3650	792	166RH	6	3	3	WHIRLD HELICOPTERS...	7640130	R66	3
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20221125	A10977_0_20221125	3575	484	166RH	6	3	3	WHIRLD HELICOPTERS...	7640130	R66	3
20221125	A10977_0_20221125	3575	484	166RH	6	3	3	WHIRLD HELICOPTERS...	7640130	R66	3
20221125	A10977_0_20221125	3575	484	166RH	6	3	3	WHIRLD HELICOPTERS...	7640130	R66	3
20221125	A10977_0_20221125	3575	484	166RH	6	3	3	WHIRLD HELICOPTERS...	7640130	R66	3
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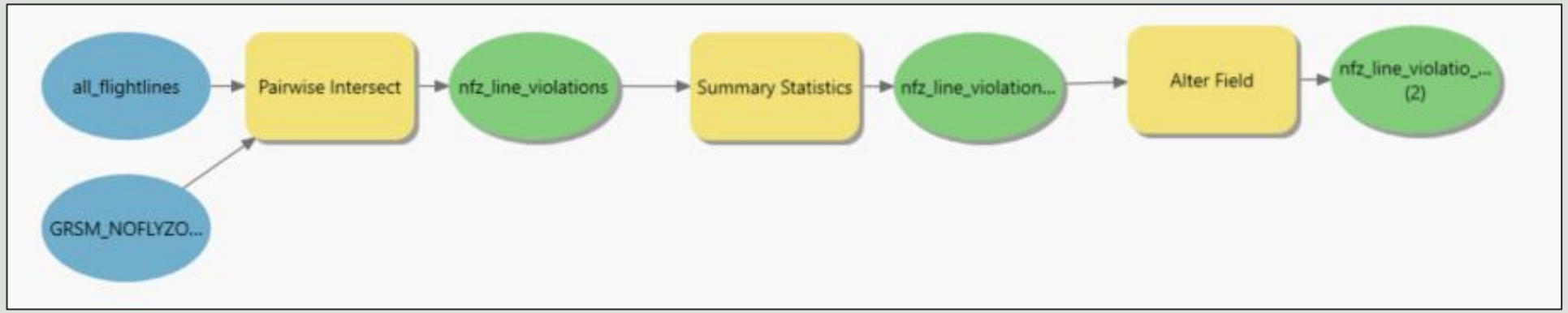
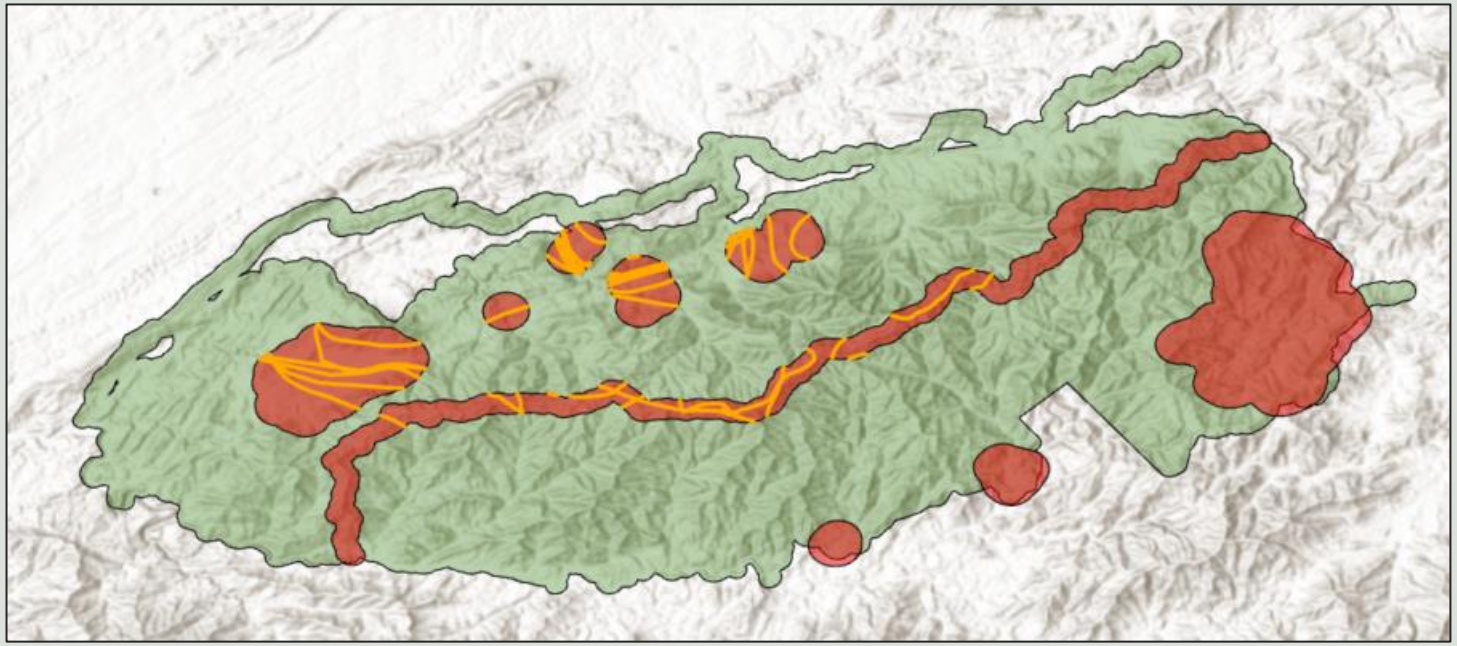
20221125	A10977_0_20221125	3525	920	166RH	6	3	3	WHIRLD HELICOPTERS...	7640130	R66	3

- Optional step
- Every point for the flight is applied the same violation attribute value
- Can be applied to flightline data as well

AUX MODEL: LINE NFZ NON-COMPLIANCE





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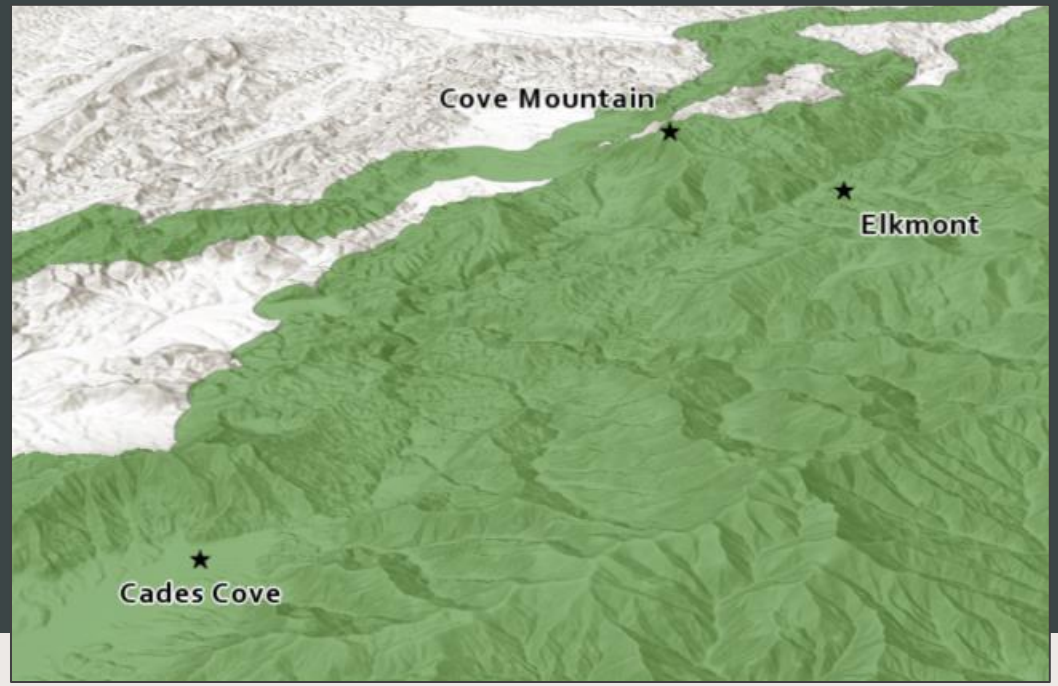
10	10	A1A96E_2_20220705	2	1
11	11	A1A96E_2_20221011	3	1

DATA LOGGER VIEWSHED ANALYSIS

Objectives

- Analyze viewshed of each data loggers at GRSM (Elkmont, Cades Cove, and Cove Mountain) and compare for each location
- Identify blind spots that impact quality of data collection
- Provide methods for NSNSD to model viewshed before deployment of data loggers in different locations

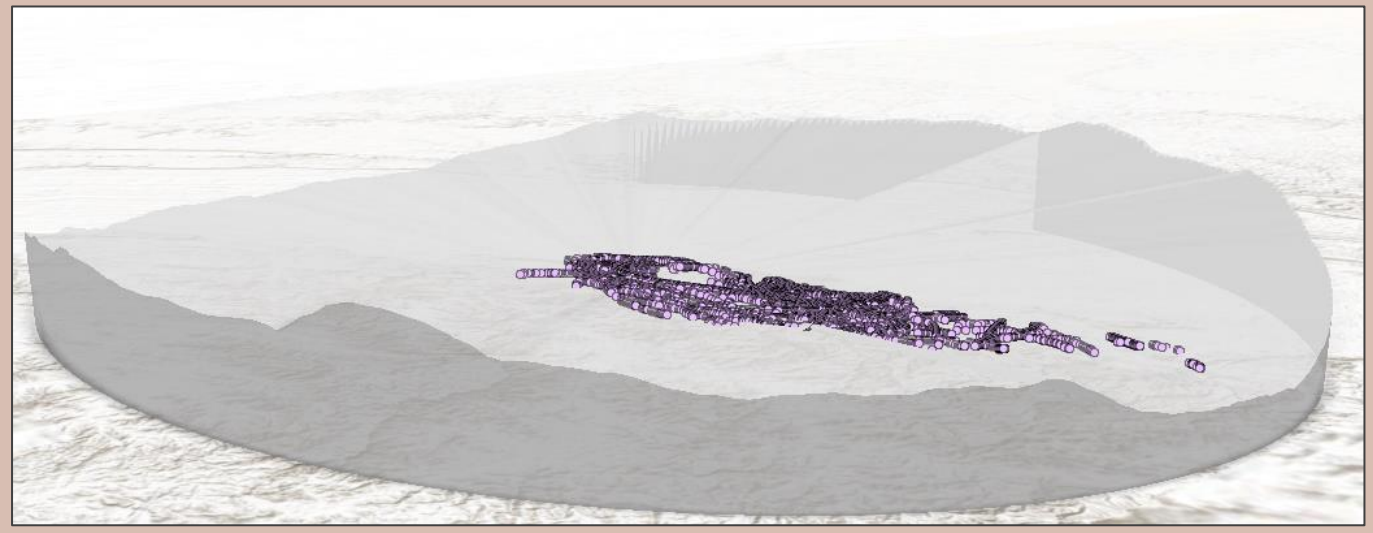


SKYLINE ANALYSIS

	A	B	C	D	E
1	id	location	lat	long	elev (m)
2	0	Cove Mountain	35.69667	-83.6097	1246
3	1	Elkmont	35.66444	-83.5903	639
4	2	Cades Cove	35.60402	-83.7829	567

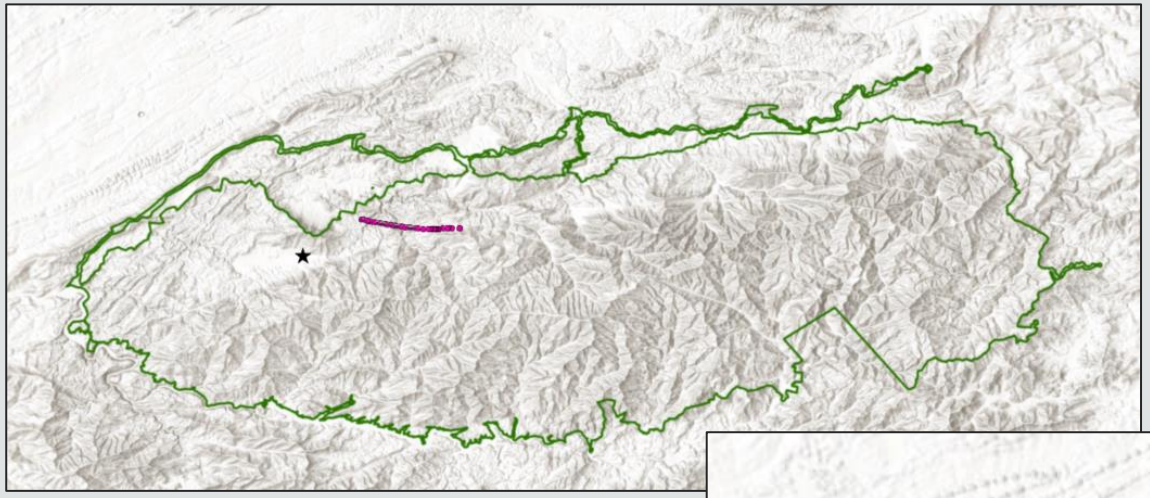
Overview

- 3D Analyst Skyline and Skyline Barrier tool allows analysis for data logger viewshed
- Utilizes 10m NED data and estimated logger locations (approximate elevation values)
- Used to compare ADS-B data for performance comparison between loggers
- Used to predict visibility for operator routes and can be run for other potential deployment sites

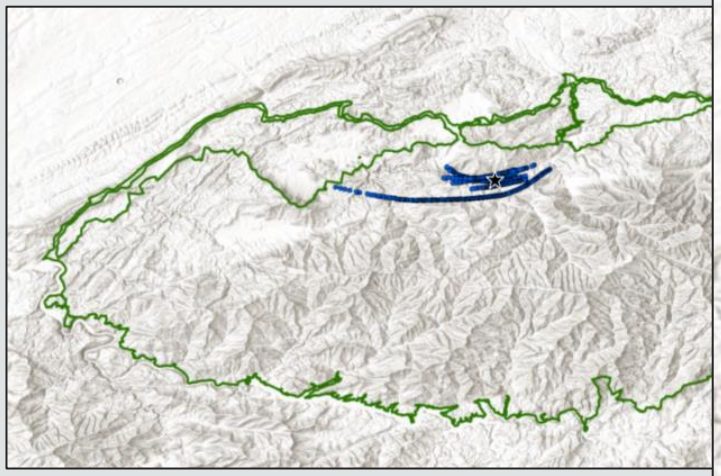


Raw ADB-S Operator Data

Cades Cove	Elkmont	Cove Mountain
69	974	220,847

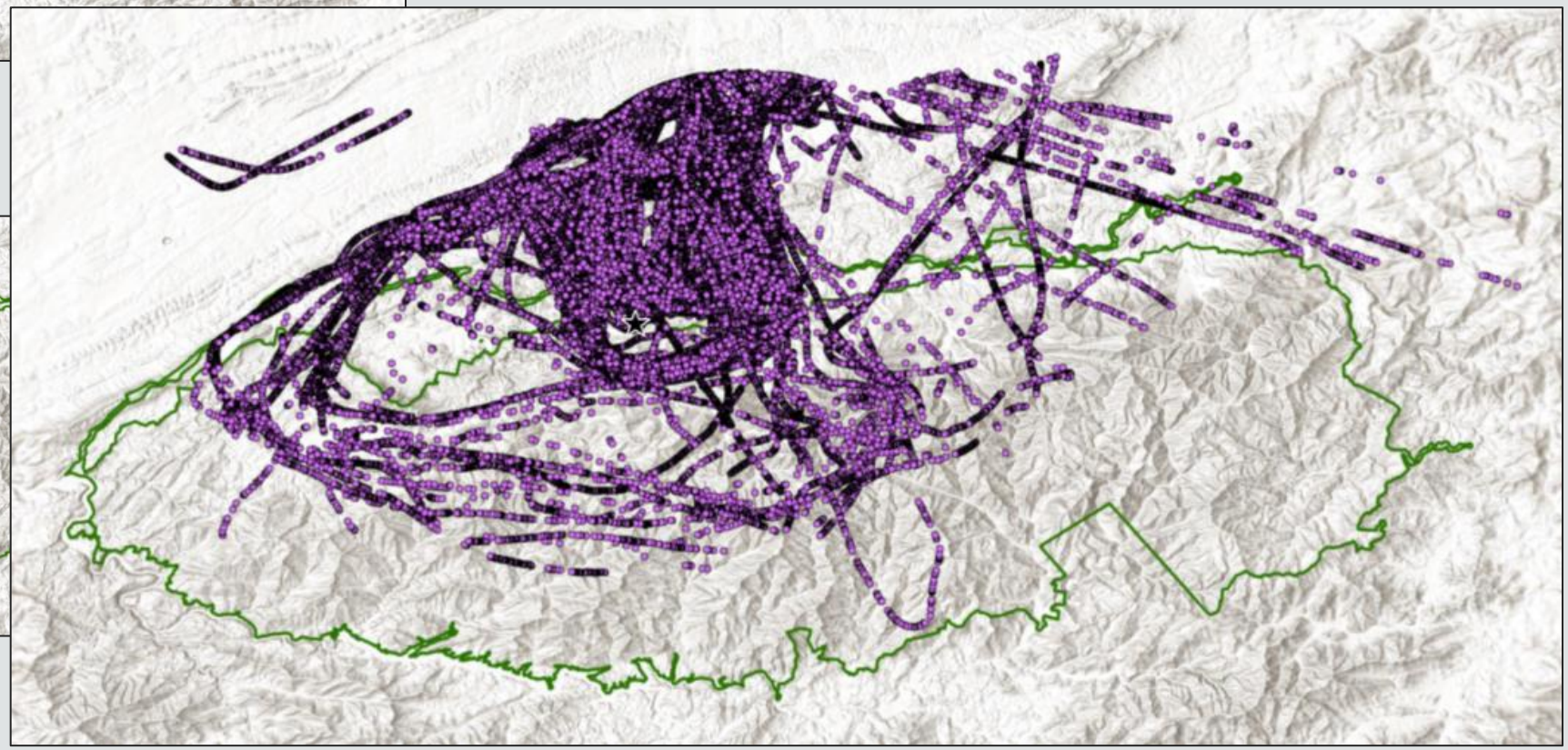


Cades Cove

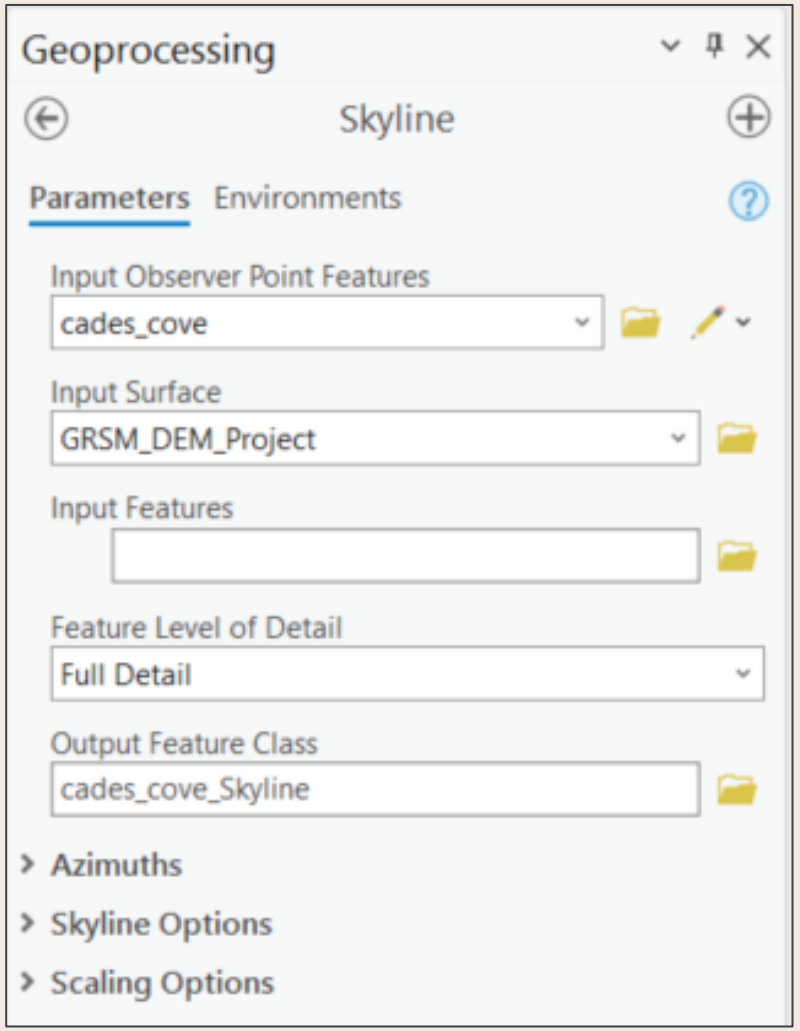


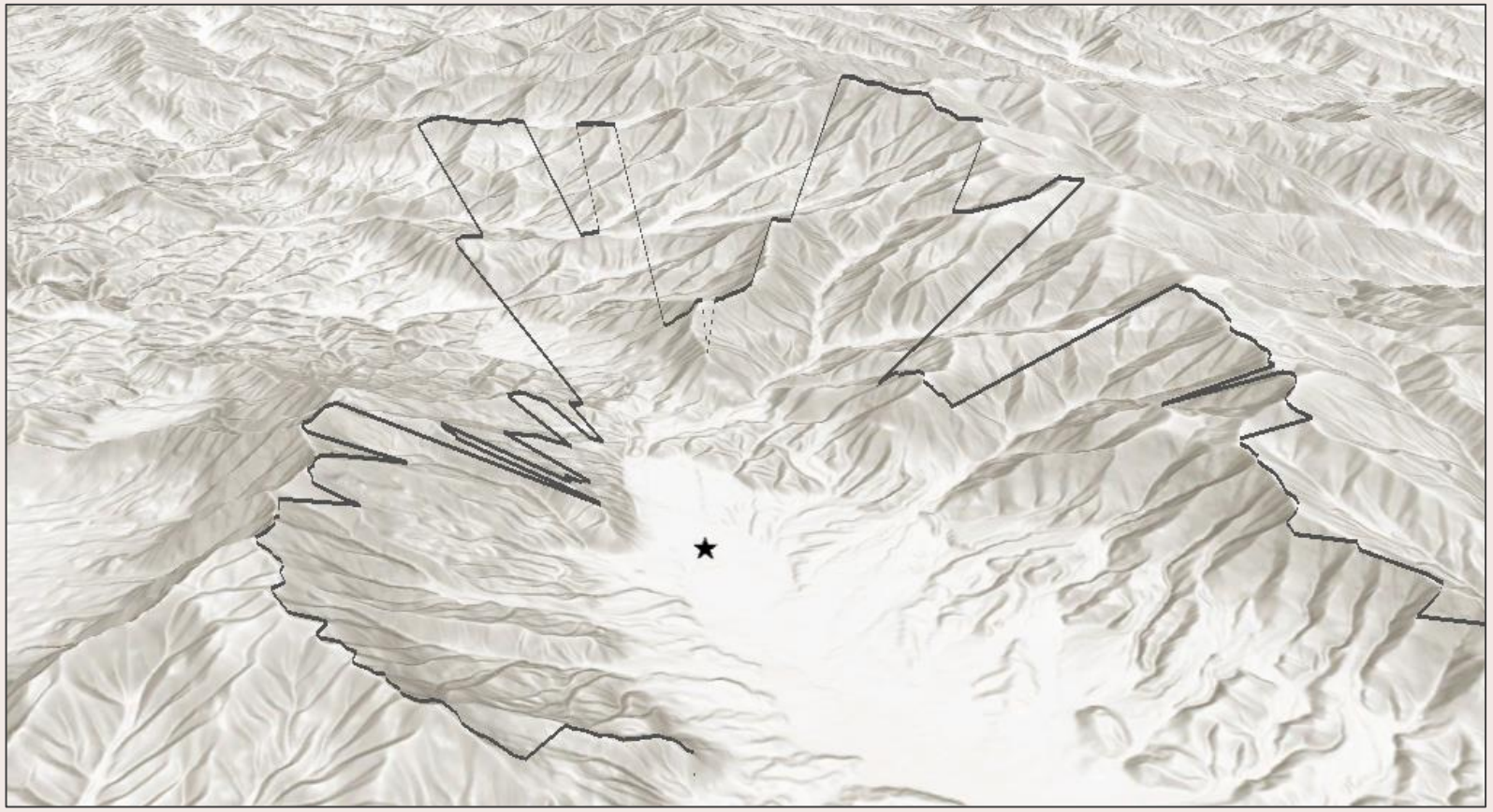
Elkmont

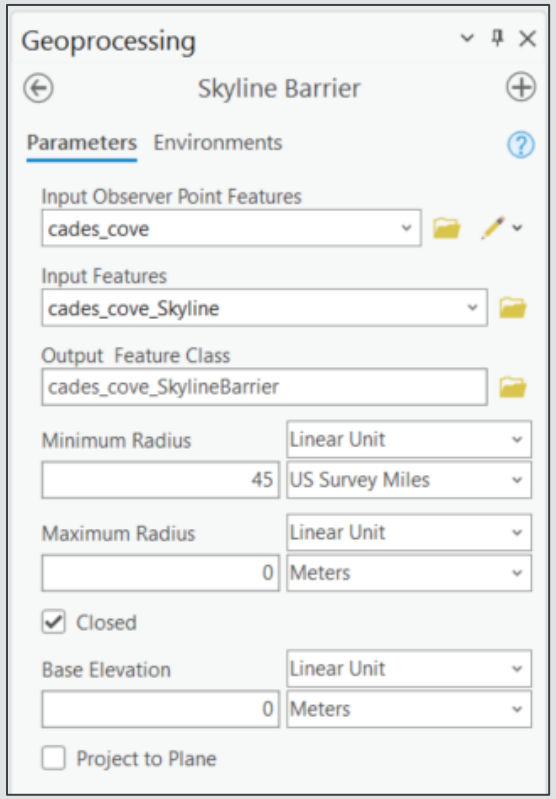
Cove Mountain

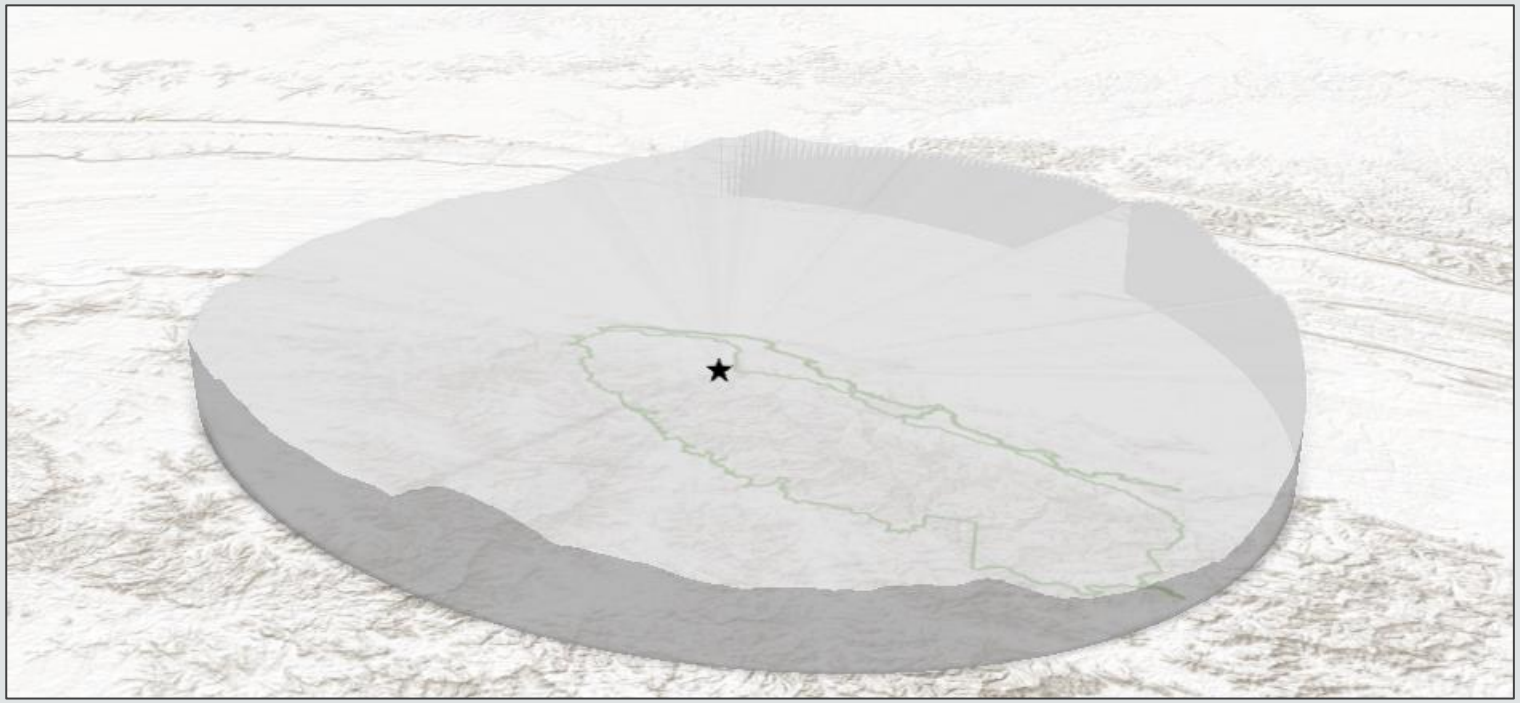


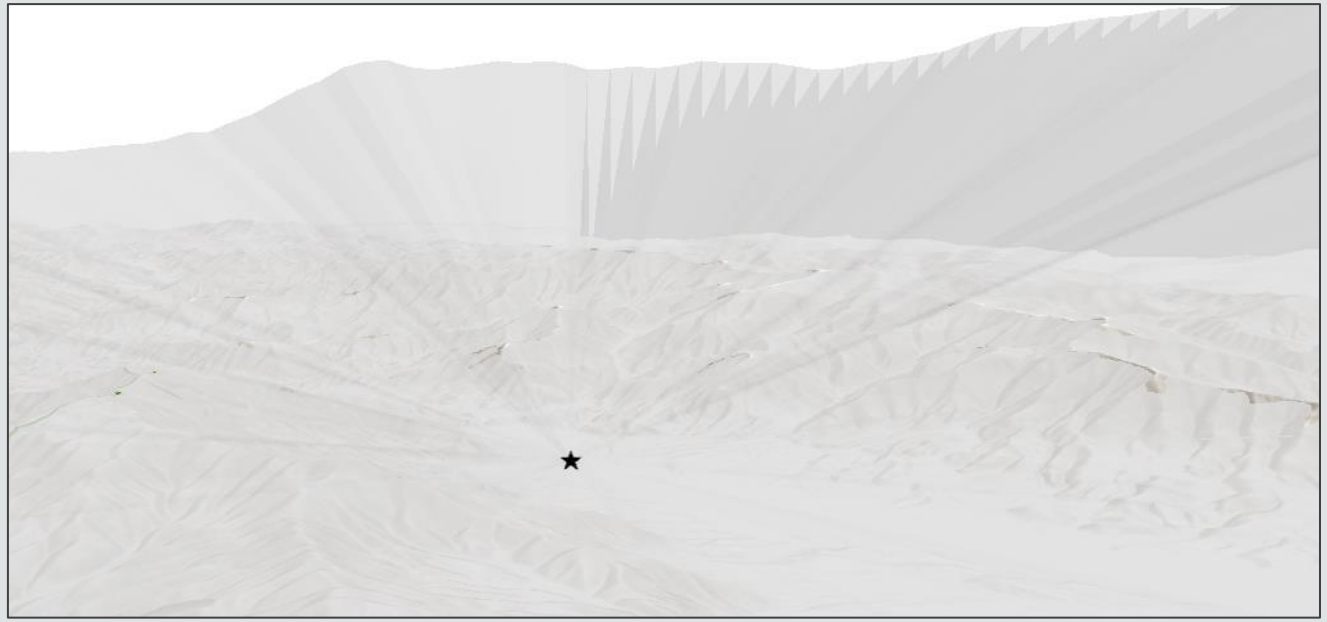
3D Analysis Skyline Tool











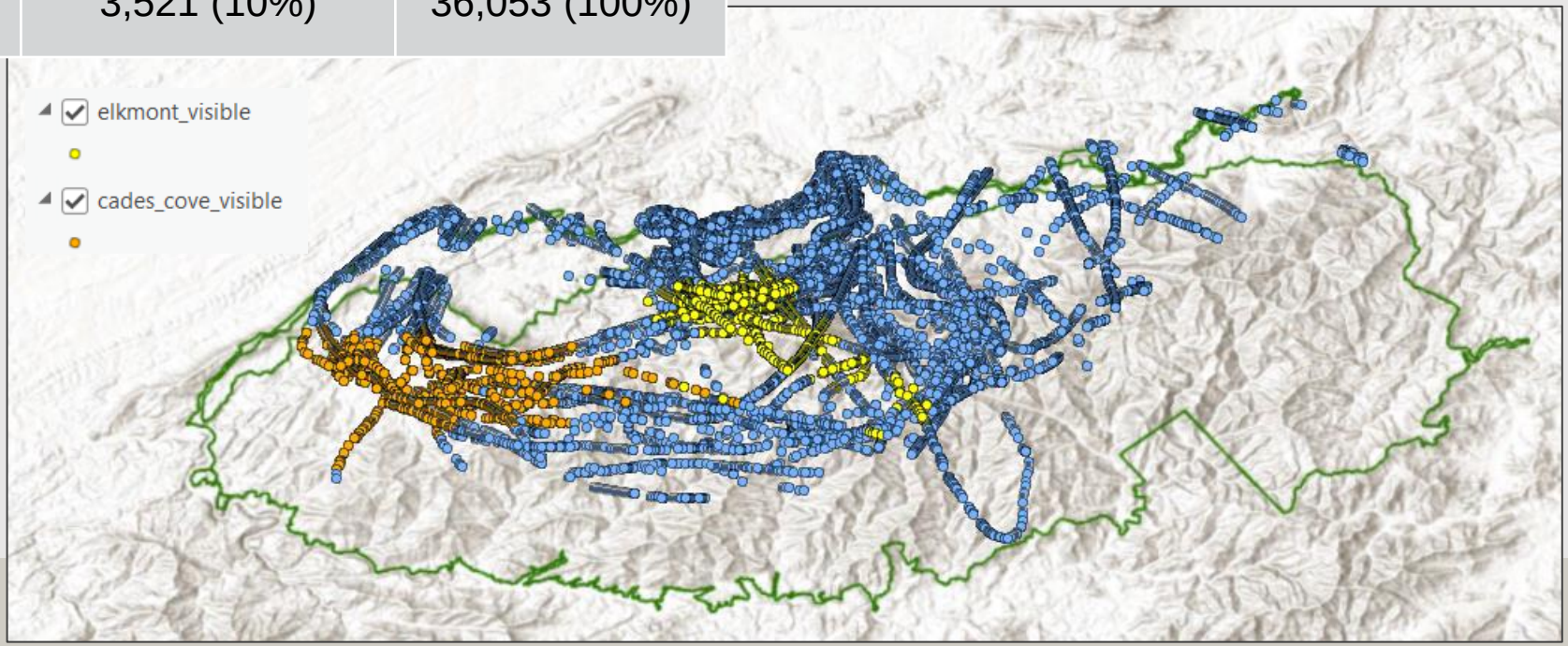
3D Analysis Skyline Barrier Tool

SKYLINE ANALYSIS RESULTS

Total Points	Cades Cove	Elkmont	Cove Mountain
36,053	1,408 (4%)	3,521 (10%)	36,053 (100%)

Results will likely vary with a fully processed and cleaned ADS-B dataset.

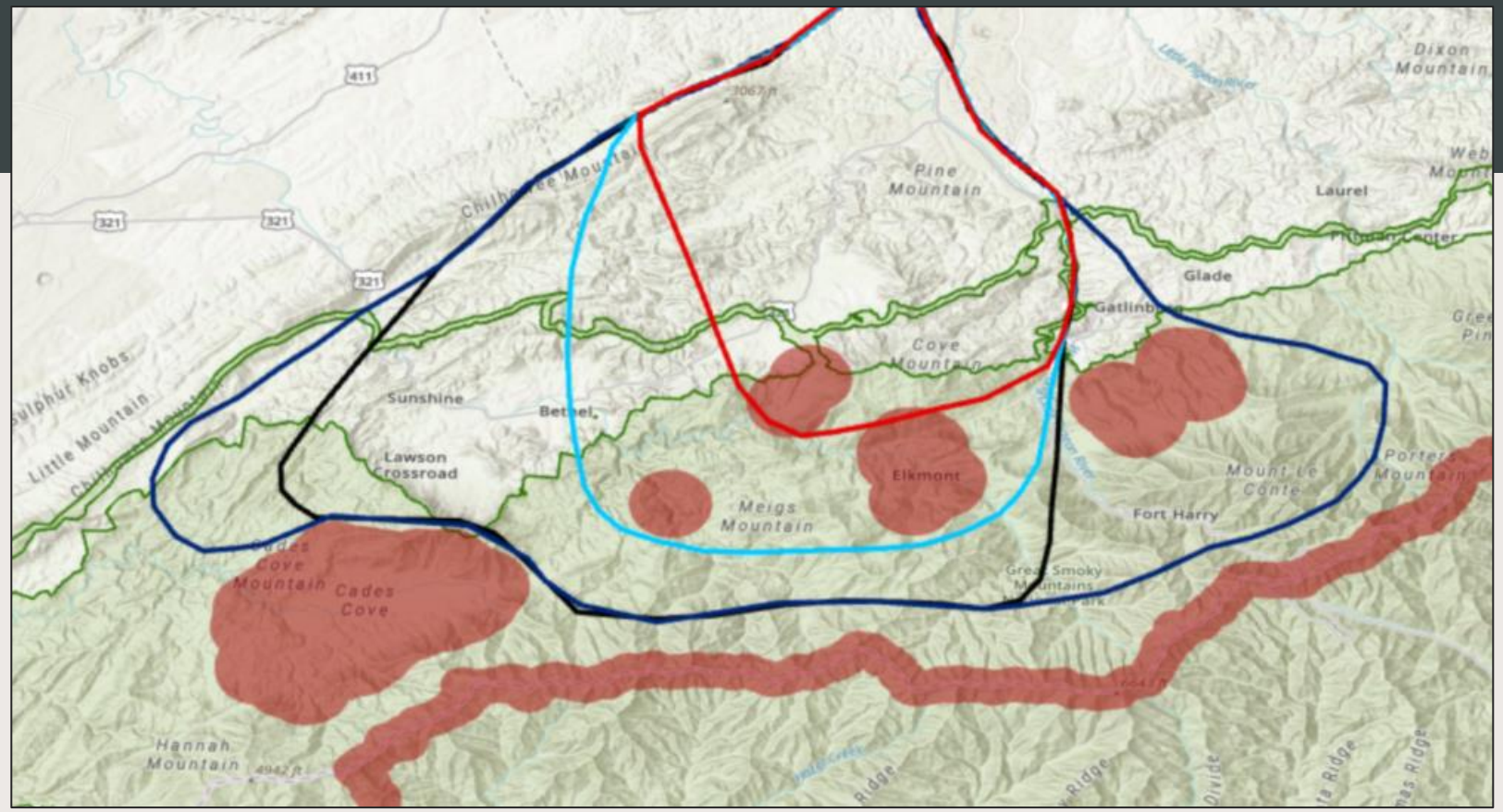
Maximum value will be comparison to operator provided data.



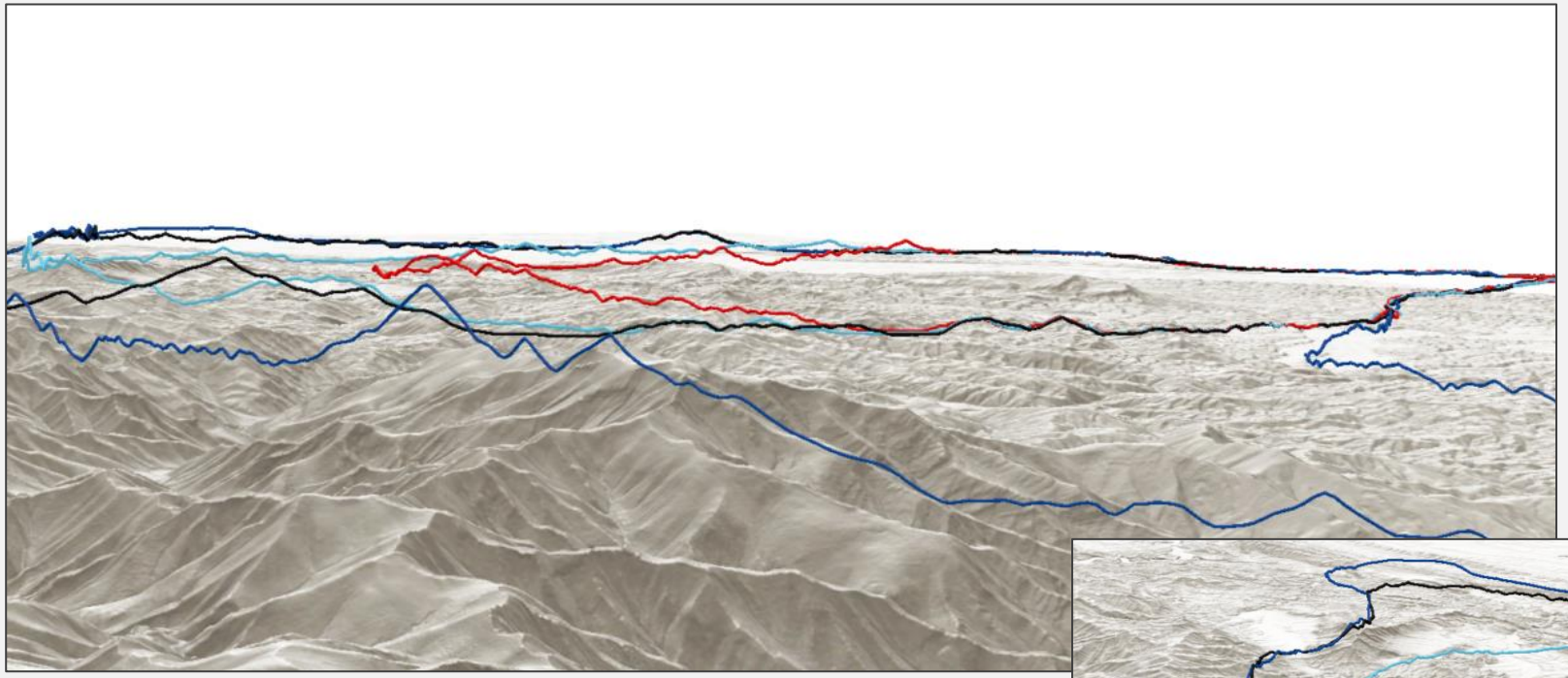
OPERATOR ROUTES

The GRSM ATMP establishes modified operator routes that avoid disrupting areas of interest within the park.

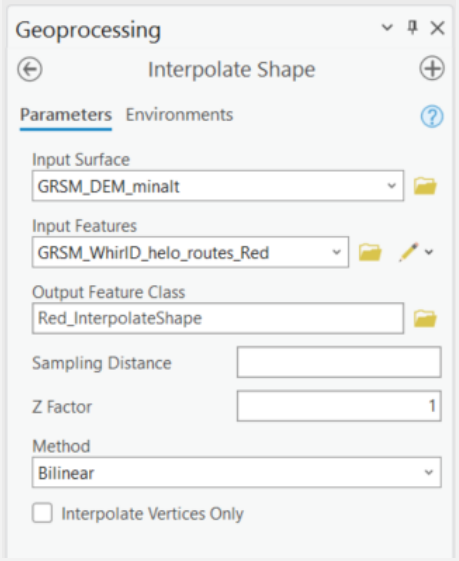
How much of the route will be visible at 2,600ft AGL?

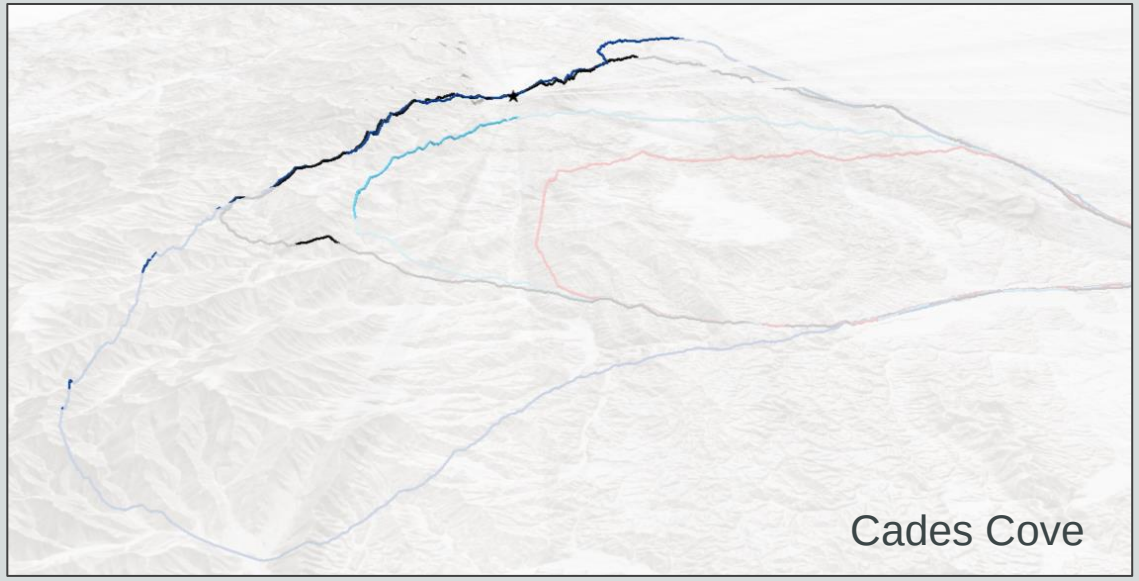


Mapping 3D Operator Routes

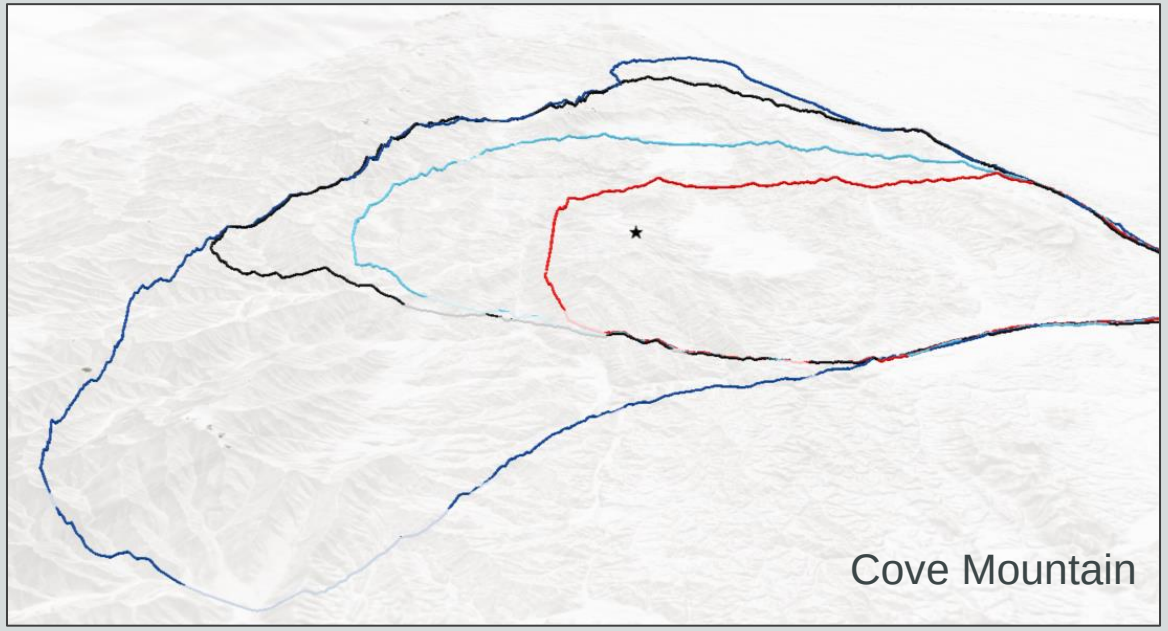


Use Raster Calculator to create new DEM that is elevated by 2,600ft.

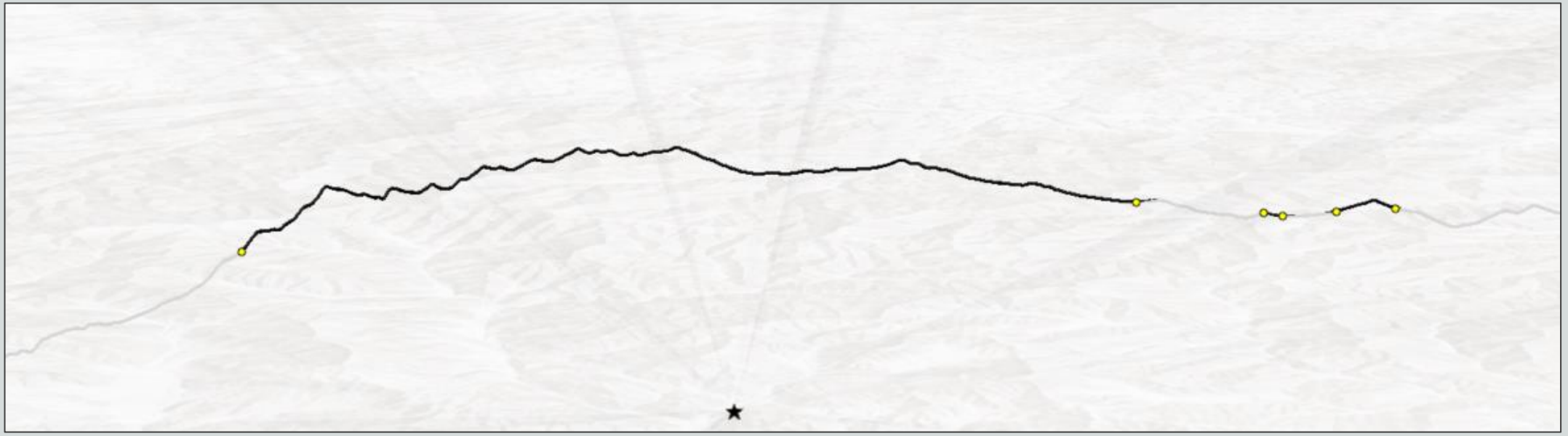




Compare 3D Routes to Skyline Barrier



Measure Visible Route Segments



Black_intersect_covemt_lines

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	OID *	Shape *	LINE_OID	FROM_MP_ID	TO_MP_ID	DIST_3D	LENGTH_3D	Shape_Length	visible
1	1	Polyline Z	2	-1	1	0	2400.948167	0.180625	yes
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3	3	Polyline Z	2	1	1	2530.432616	440.72504	0.019187	yes
4	4	Polyline Z	2	1	1	2971.157656	66.020792	0.004709	no
5	5	Polyline Z	2	1	1	3037.178448	552.828781	0.015852	yes
6	6	Polyline Z	2	1	1	3590.007229	587.593373	0.027261	no
7	7	Polyline Z	2	1	1	4177.600602	44.52823	0.002639	yes
8	8	Polyline Z	2	1	1	4222.128833	335.009259	0.021689	no
9	9	Polyline Z	2	1	1	4557.138092	8016.763587	0.271059	yes
10	10	Polyline Z	2	1	1	12573.901679	42.642598	0.002821	no
11	11	Polyline Z	2	1	-1	12616.544276	10346.395369	0.490153	yes

Click to add new row.

Geoprocessing

Intersect 3D Line With Multipatch

Parameters Environments

Input Line Features: Black_InterpolateShape

Input Multipatch Features: elkmont_SkylineBarrier

Join Attributes: Only Feature ID Numbers

Output Points: Black_intersect_elkmont_points

Output Lines: Black_intersect_elkmont_lines

Scene

3D Layers

- black_covemt_intersect_points
- black_elkmont_intersect_points
- black_codescove_intersect_points
- black_covemt_intersect_lines
- black_elkmont_intersect_lines
- black_codescove_intersect_lines

ROUTE VISIBILITY RESULTS

Route	Total Length	Cades Cove	Elkmont	Cove Mountain
Red	42.58 mi	0 mi (**0%**)	6.35 mi (**15%**)	40.38 mi (**95%**)
Light Blue	50.89 mi	8.75 mi (**17%**)	8.98 mi (**18%**)	45.54 mi (**89%**)
Blue	80.94 mi	22.54 mi (**28%**)	9.15 mi (**11%**)	75.88 mi (**94%**)
Black	65.03 mi	18.1 mi (**28%**)	8.96 mi (**14%**)	60.71 mi (**93%**)

CONCLUSION

ATMP Non-Compliance Models

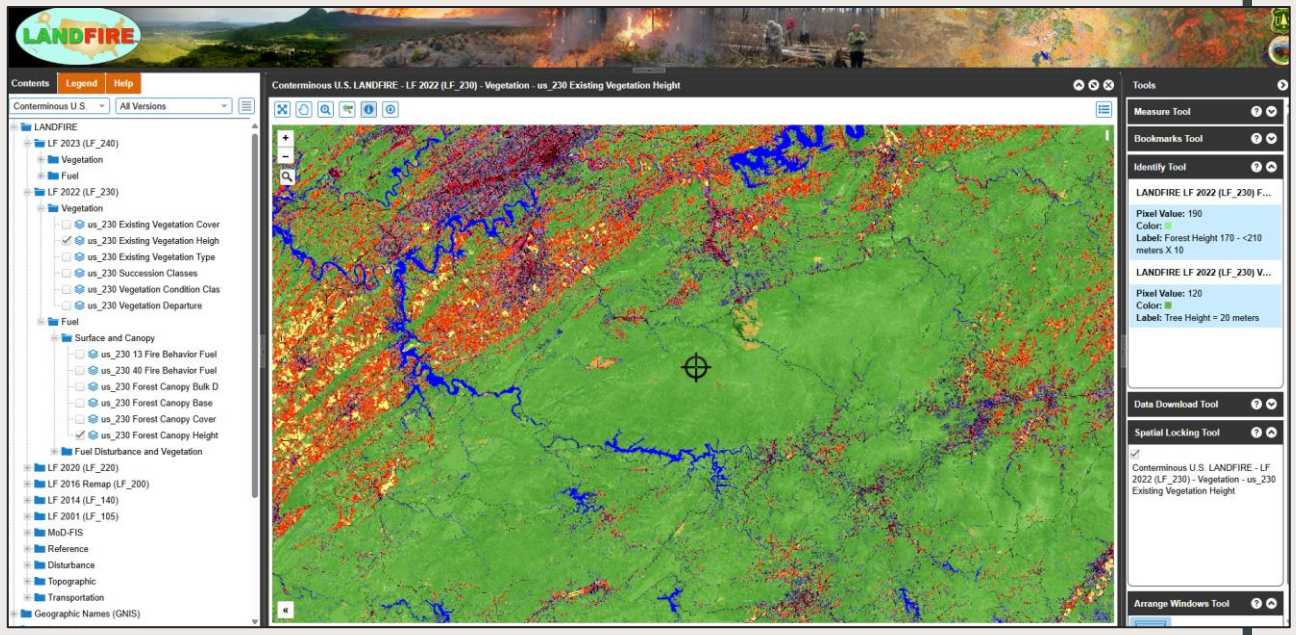
- Developed using ADS-B data, but designed for operator provided data
- All models will be provided to NSNSD for further use and implementation
- Recommend additions to ADS-B Overflight Analysis Toolbox if possible

Data Logger Viewshed Analysis

- Cove Mountain is a good deployment location, Elkmont and Cades Cove provide limited value for operator routes
- The results will change once operators start flying higher than 2,600 ft AGL (but how much?)
- Can be used to vet new data logger deployment locations

LIMITATIONS

- ADS-B data should be compared to operator provided data (GPS data)
- Could use higher resolution DEM (compared to 10m NED)
- Include vegetation, buildings, and other barriers to ADS-B detection in skyline analysis



LANDFIRE Map Viewer

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elk5367@psu.edu

NPS POC: Dr. Sharolyn Anderson

PSU Advisor: Dr. Nathan Piekielek