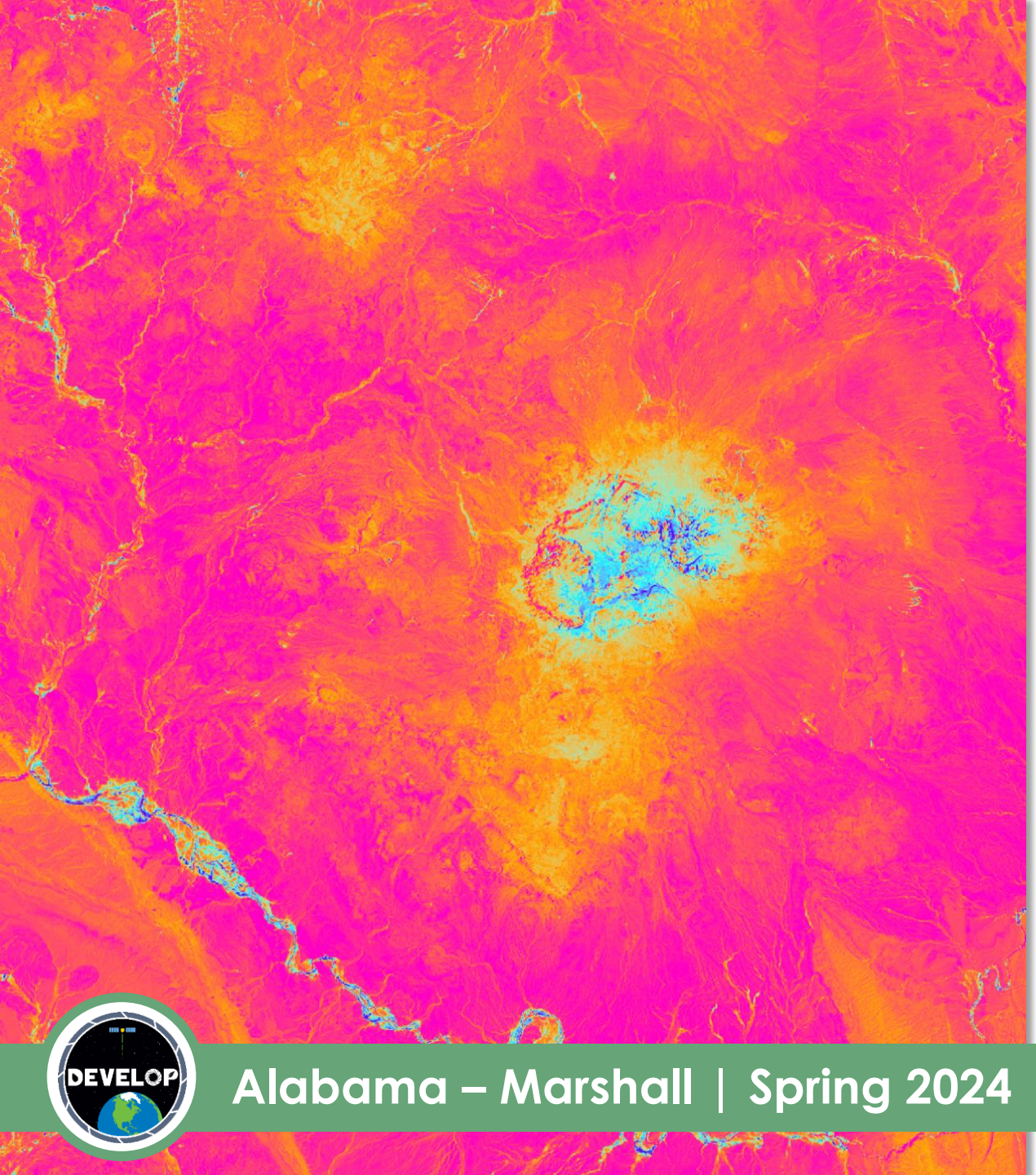

National Aeronautics and Space Administration

BIG BEND ECOLOGICAL CONSERVATION

Integrating Earth Observations into Invasive Species Management Decisions in Big Bend National Park in Texas

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Alabama – Marshall | Spring 2024

Background

Buffelgrass stand in Big Bend National Park
Image Credit: National Park Service

- Invasive perennial grasses, specifically Buffelgrass ***Cenchrus ciliaris***, have disrupted dryland ecosystems within the southwest United States
- Originally introduced for erosion control and foraging, they now **threaten biodiversity** and **increase fire risk** in protected areas such as Big Bend National Park
- **Remote sensing** has historically exposed limitations in the spatial analysis of invasive grasses

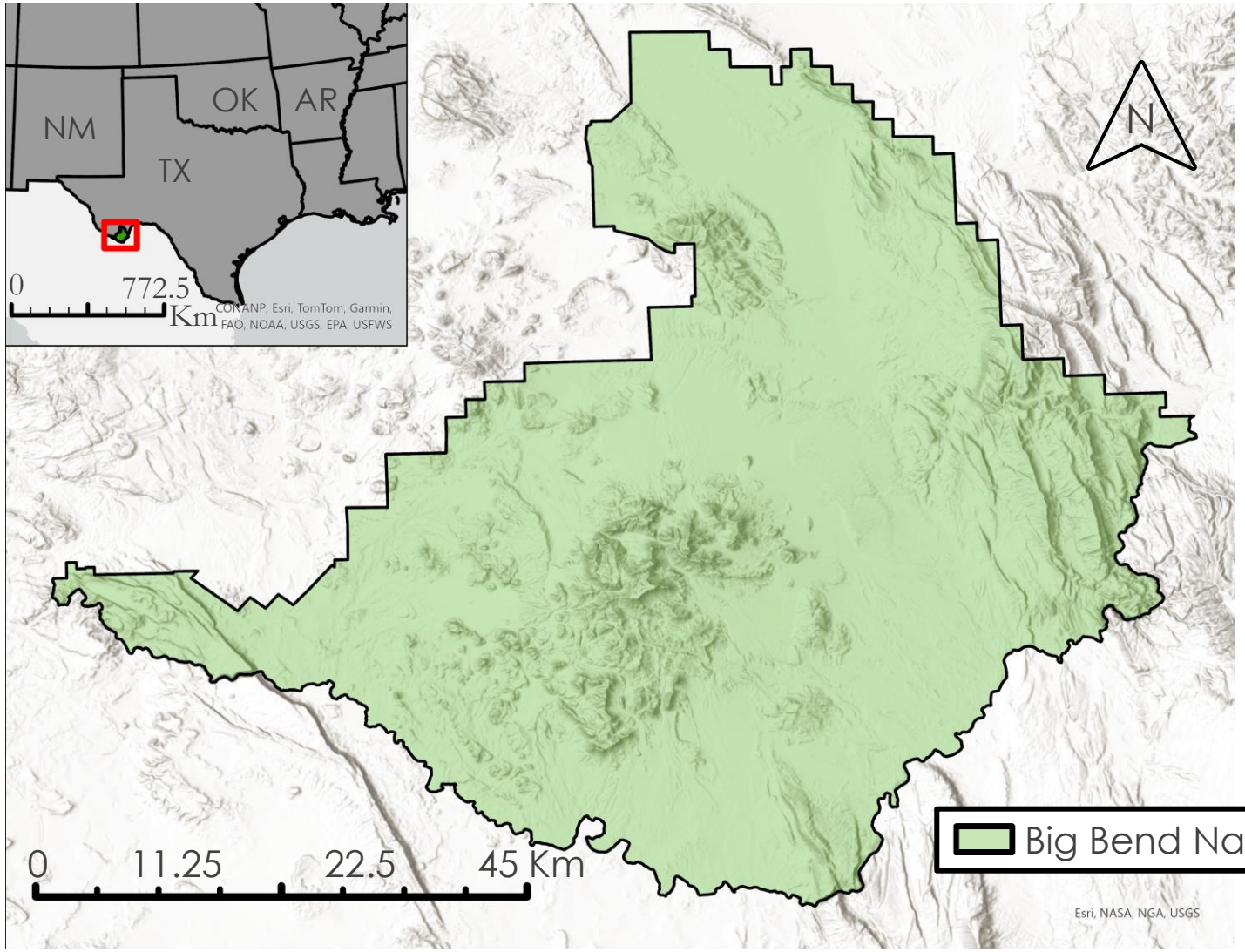
The Partner: National Park Service

Community Concerns

- Inefficient **fire risk mitigation strategies** threaten staff, visitors, and protected areas in the park
- **Invasive flora species** disturb natural ecosystems, out compete native species, and aid in fire risk
- Locations of **Buffelgrass** hotspots are relatively unknown and compromise management efforts

Image Credit: Big Bend National Park

Study Area: Big Bend National Park, Brewster County, Texas



Basic Information

- **Big Bend National Park** is found in the southwest part of Texas, sharing a border with Mexico
- 3,243 square kilometers of desert, mountains, and rivers
- Largest protected area of the **Chihuahuan Desert** in the US

Objectives

Create a reproducible model

Model invasive species risk

Detect Buffelgrass using remote sensing

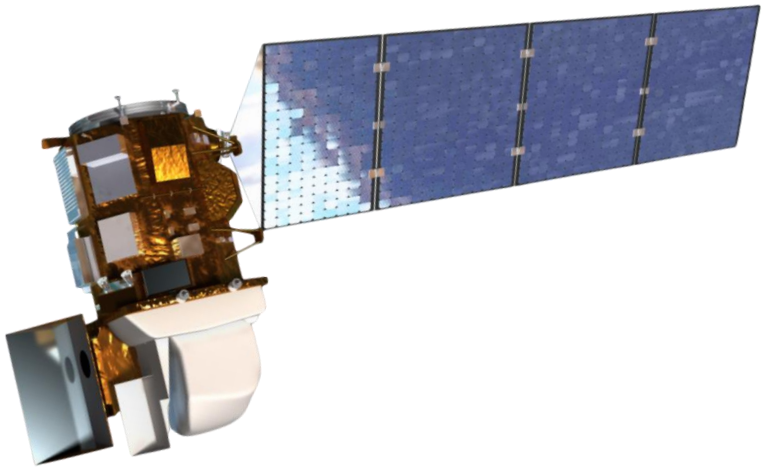
Habitat Restoration

Invasive Species Management

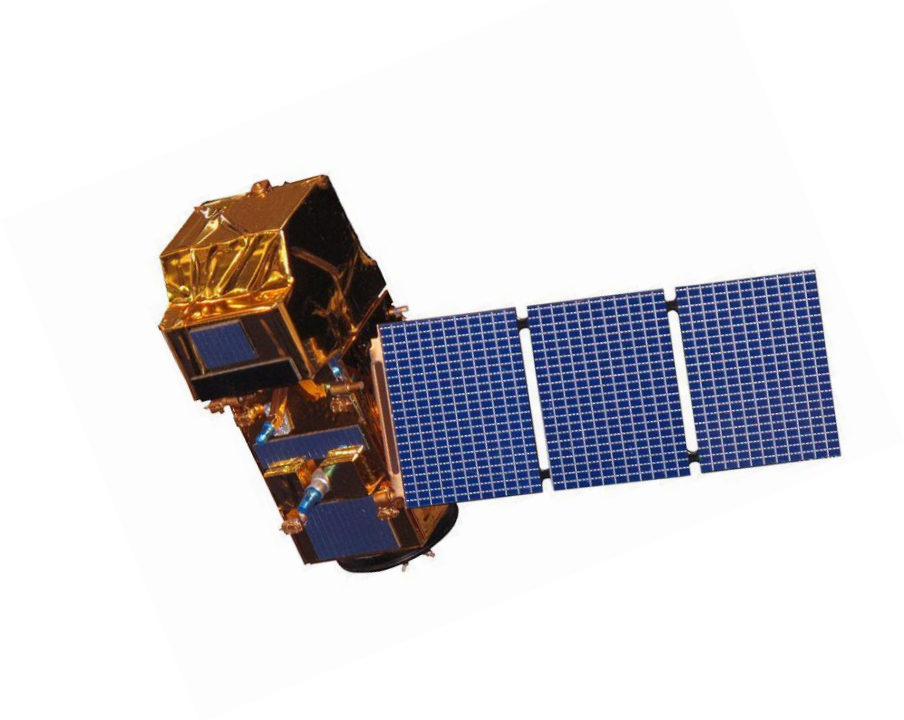
Fire Risk Assessment

Invasive Species Mapping

Earth Observations



Landsat 8 OLI

Sentinel 2A & B MSI



Image Credits: NASA, Rama

Spectral Imagery

Normalized Difference Vegetation Index (NDVI)

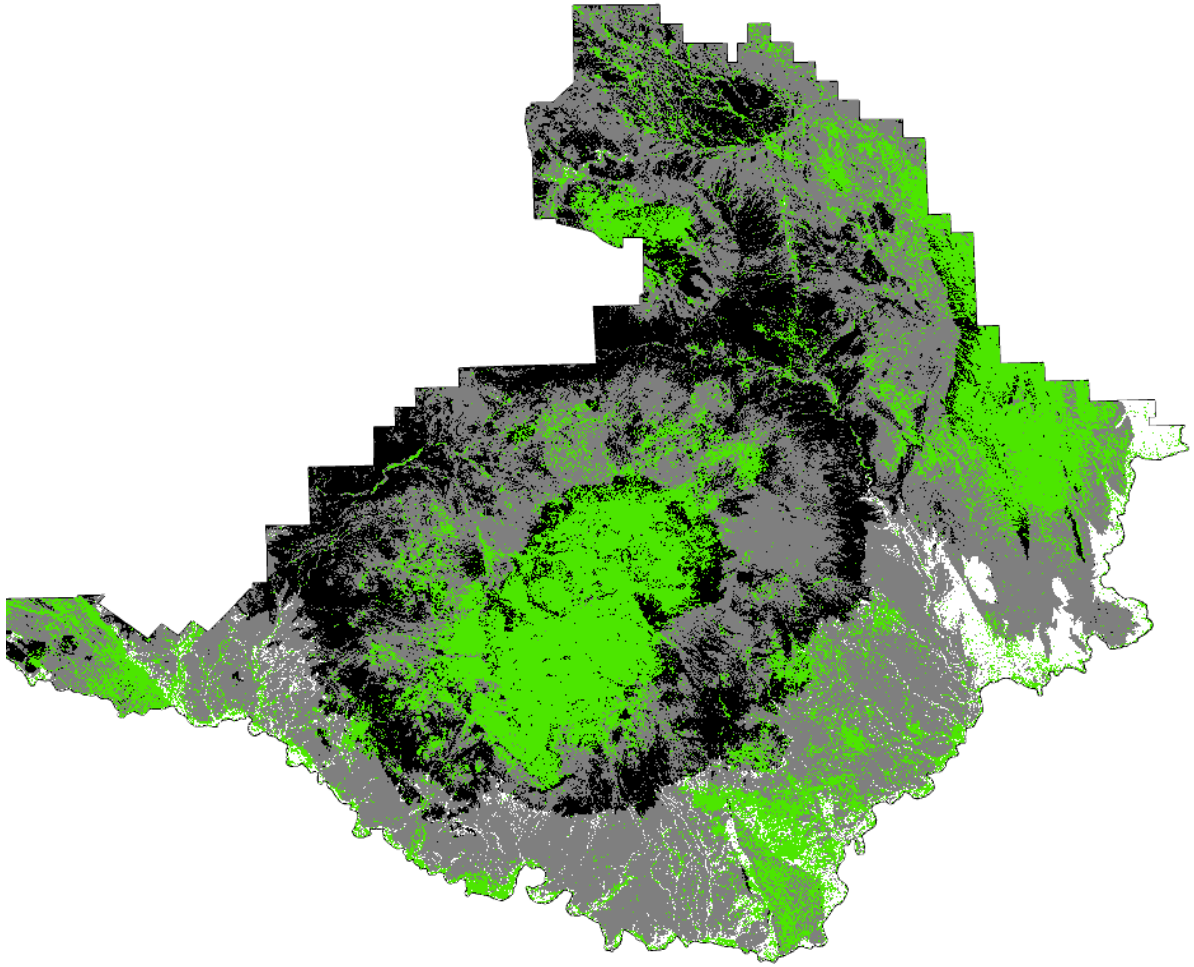
- Landsat 8 OLI for 2013, 2017–2019 & 2023
- Targeted NDVI values at 0.15 to 0.35
- Less than 5% cloud cover

Multi-Source Land Imaging (MuSLI)

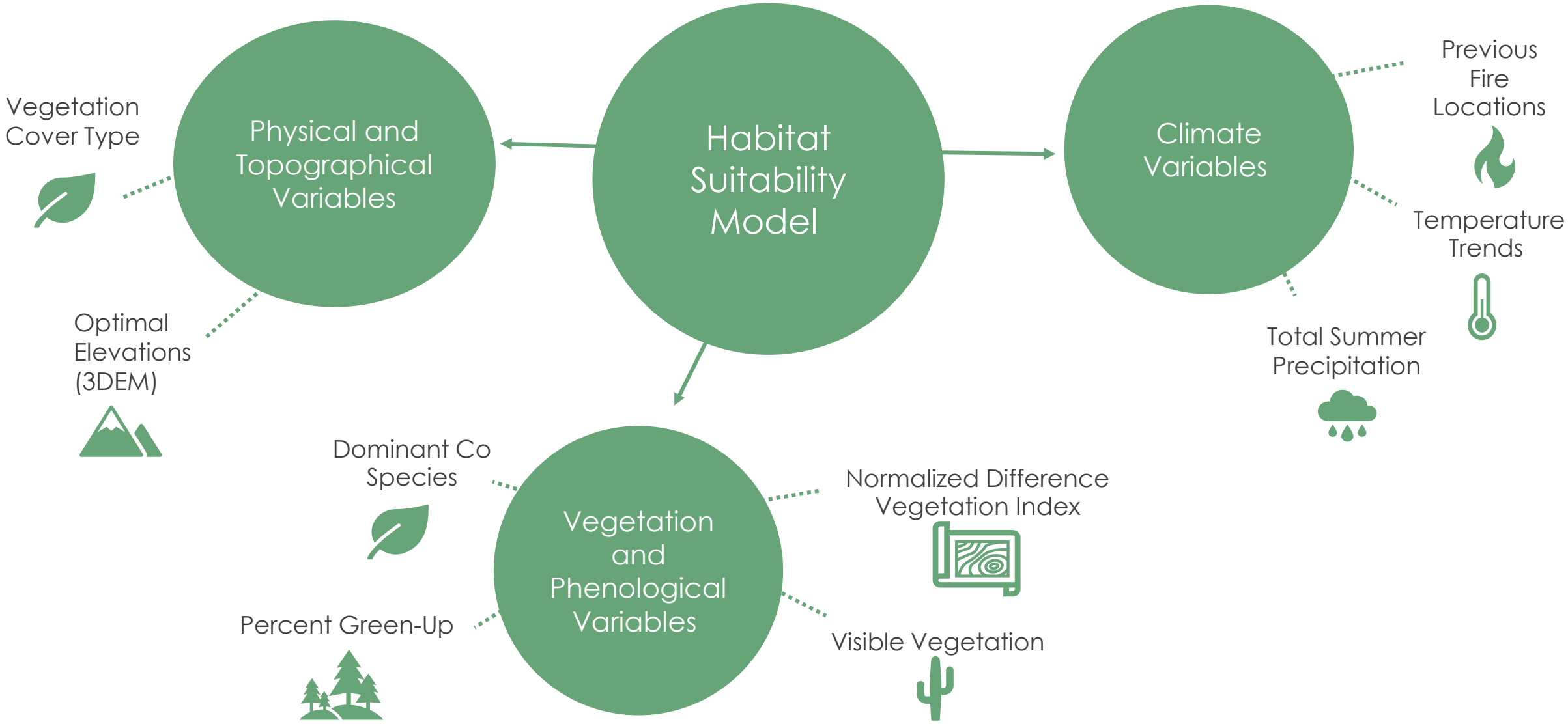
- 90% maximum greening increase (OGMx)
- Coupled NDVI & OGMx for Habitat Model 2017–2019
- 2016–2023 data used for Buffelgrass detection map

ArcGIS Pro

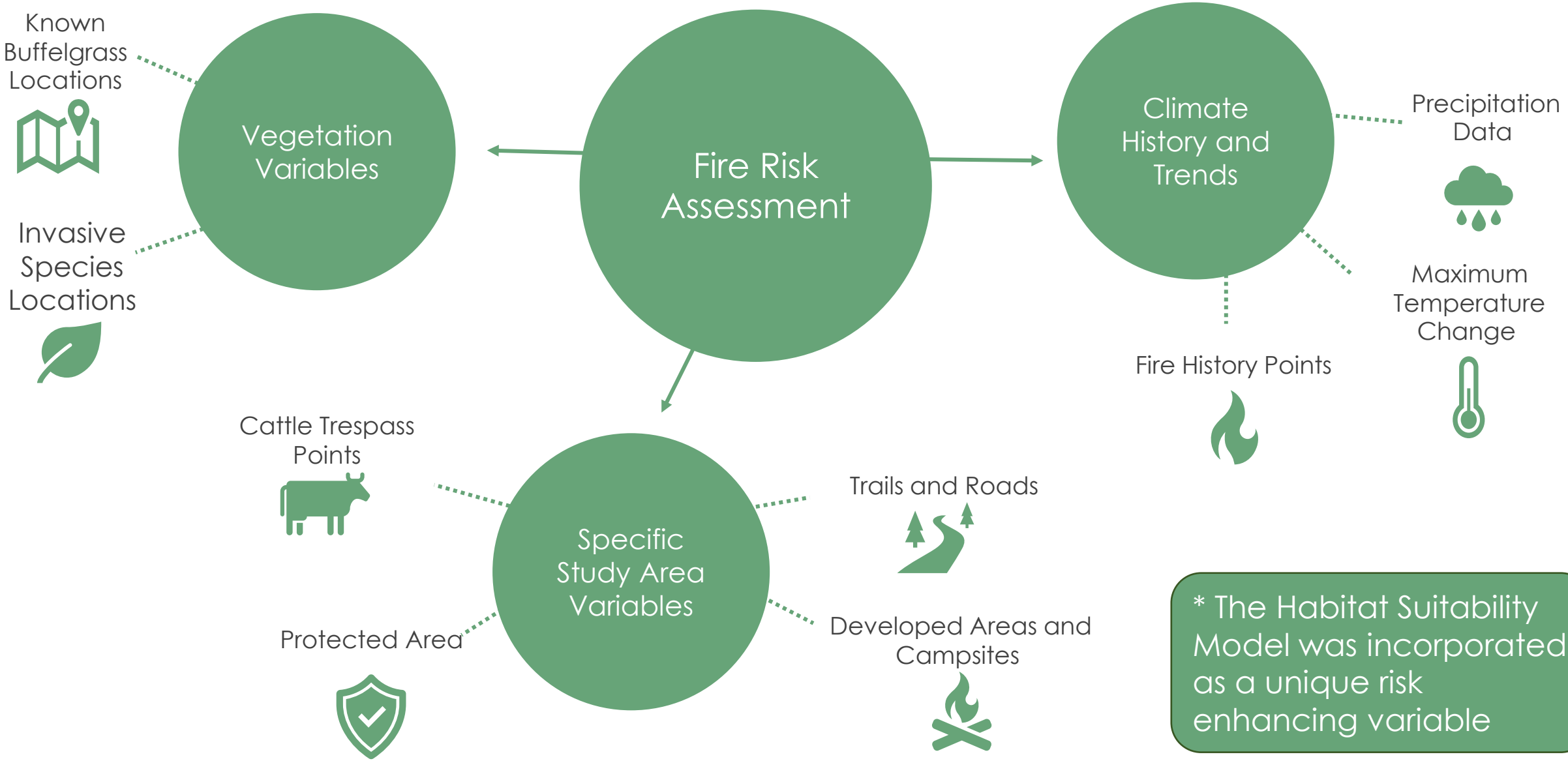
- All spectral imagery processed in ArcGIS Pro



Habitat Suitability Model Methodology

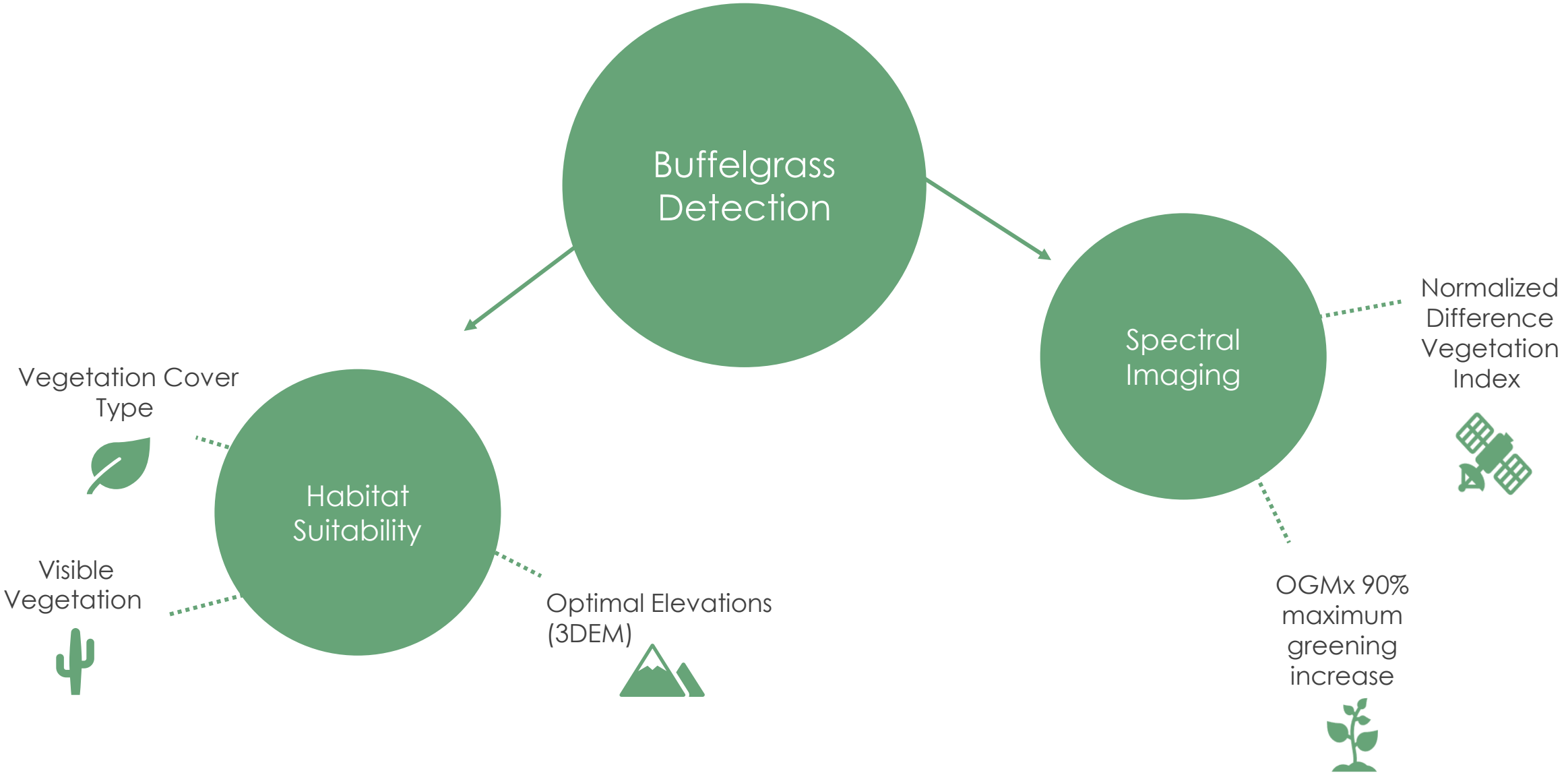


Fire Risk Assessment Methodology

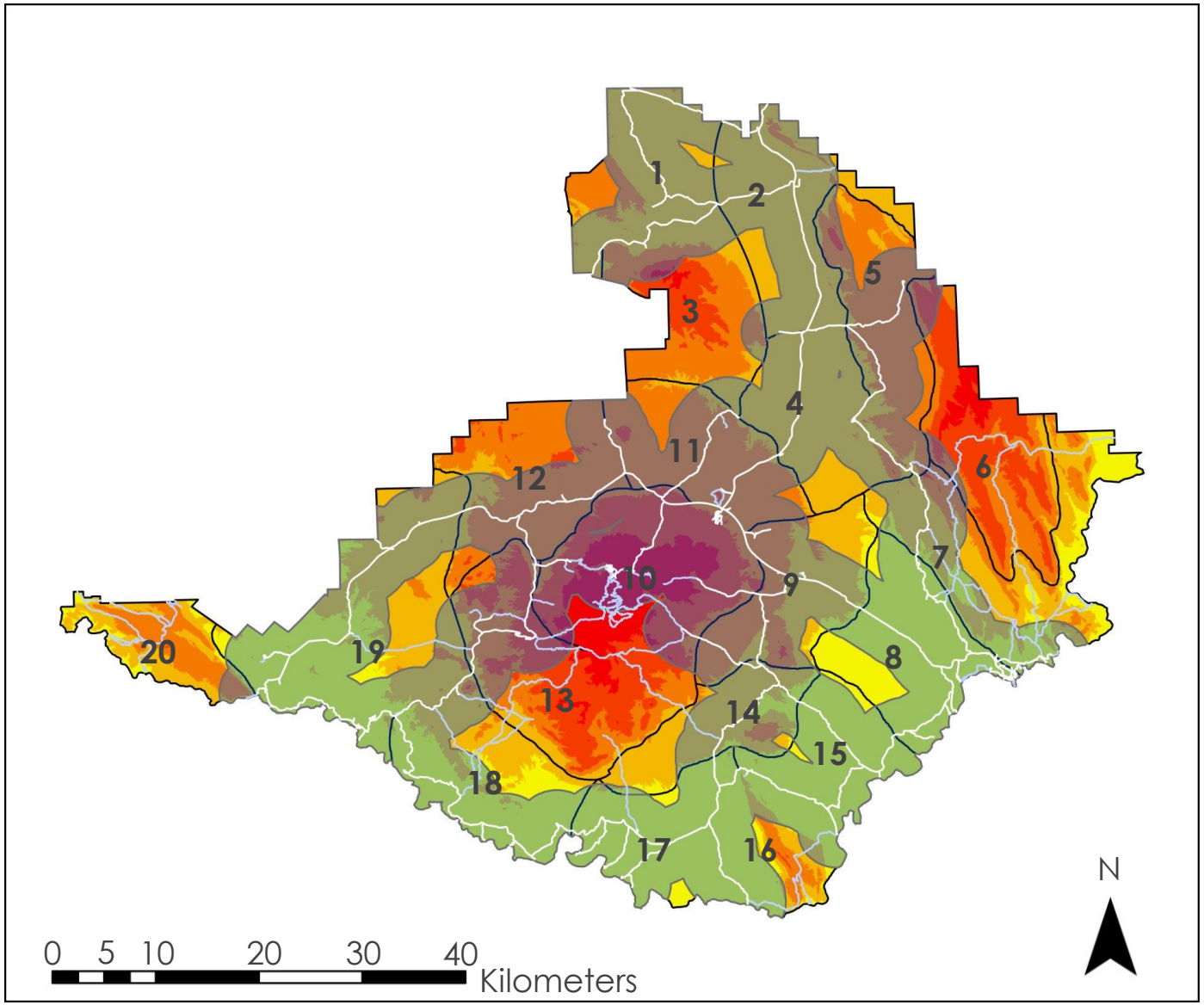


* The Habitat Suitability Model was incorporated as a unique risk enhancing variable

Buffelgrass Detection Model Methodology



Geospatial Park Zoning Methodology



Analysis Factors

- Roads
- Trails
- 2-mile Road Buffer

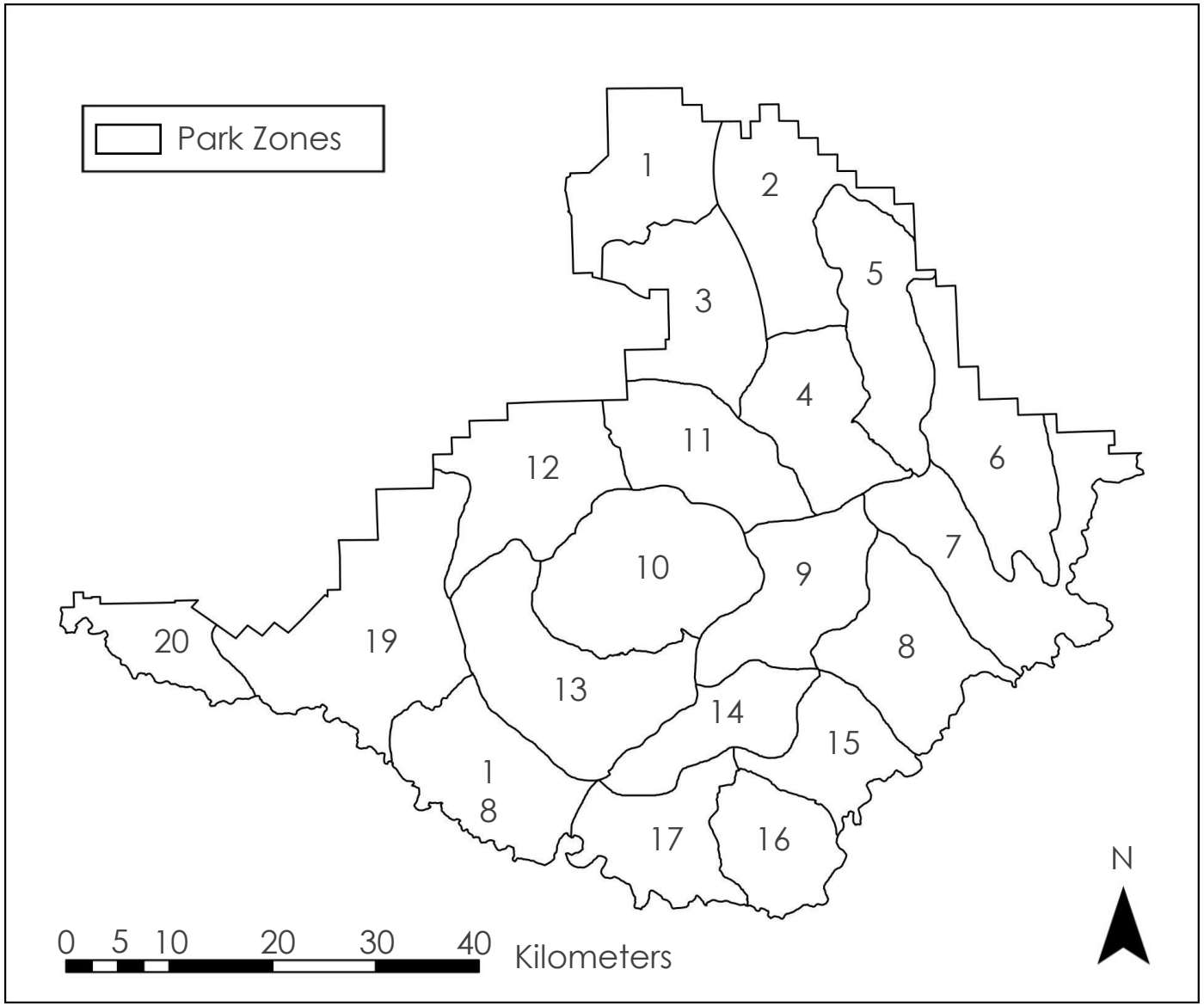
Elevation (m)

- 521–761
- 761–951
- 951–1,170
- 1,170–1,520
- 1,520–2,381

Zones were determined by

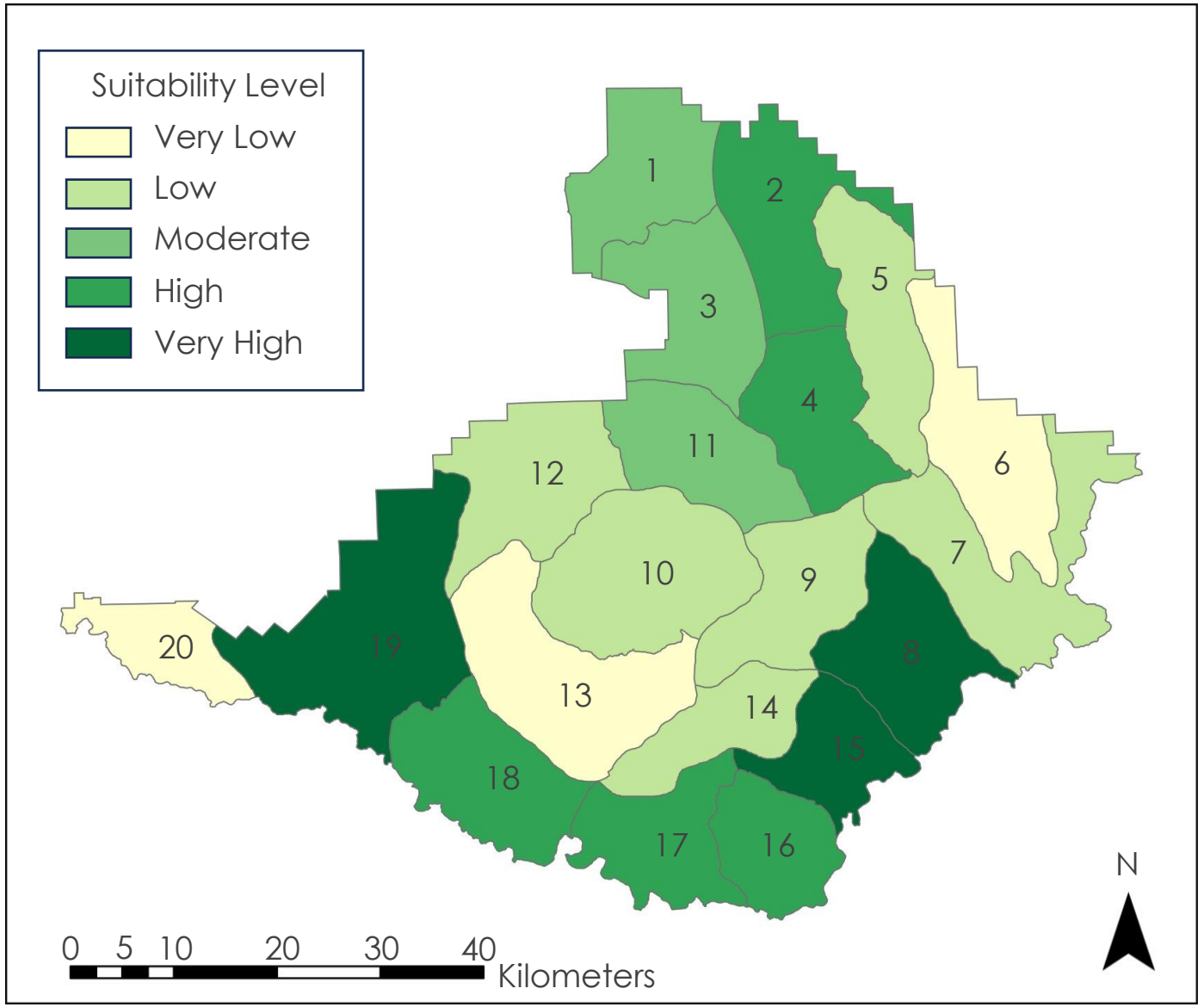
- Elevation
- Road & Trail Access
- Infrastructure
- Campsites

Geospatial Park Zoning Results



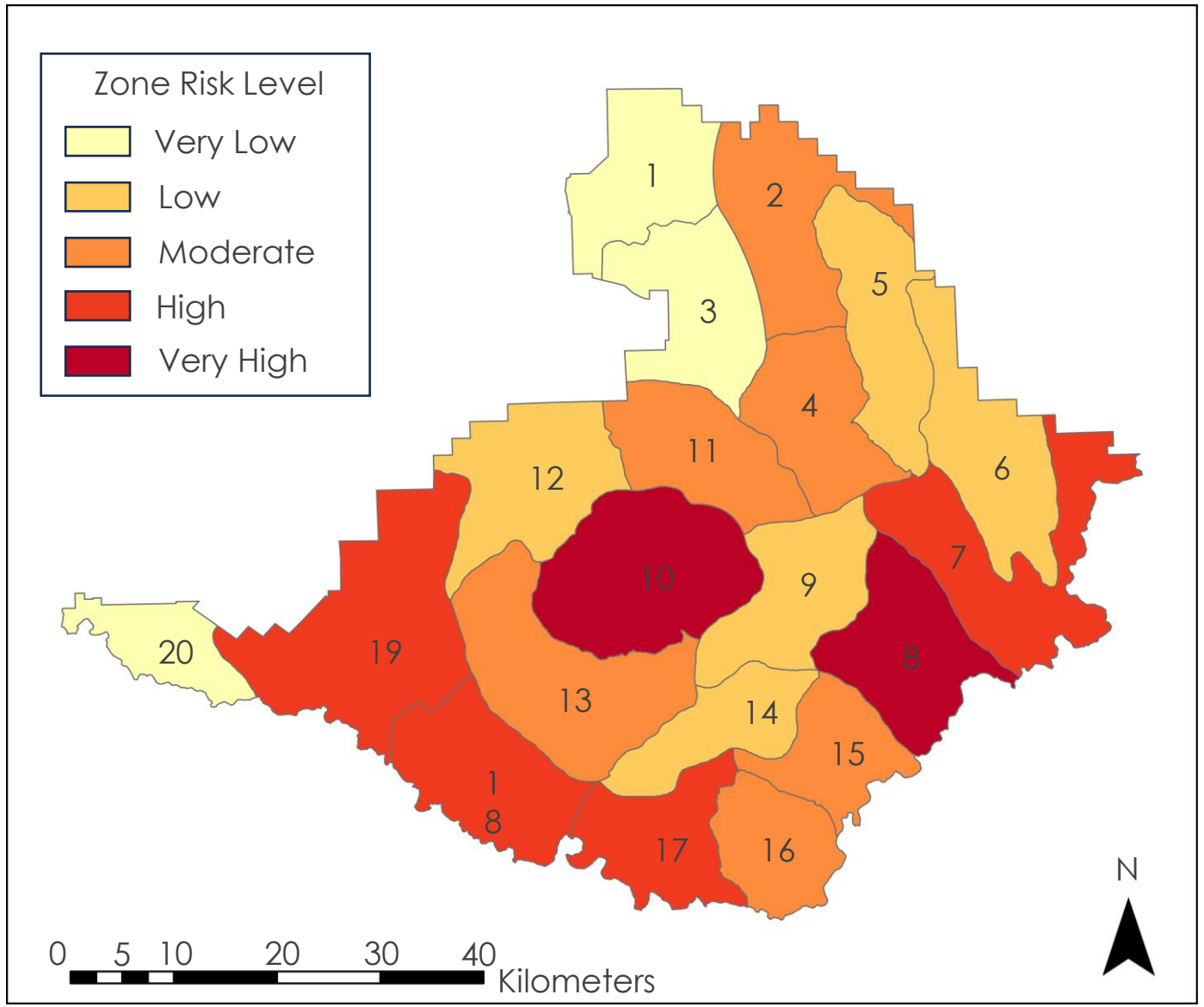
- **Zones** were created to assist the NPS in invasive grass species management
- These zones will allow a more systematic approach to **fire risk mitigation**
- Viewing **Big Bend National Park** by zones rather than the entire 3,243 square kilometers of land will greatly improve efficiency

Habitat Suitability Results



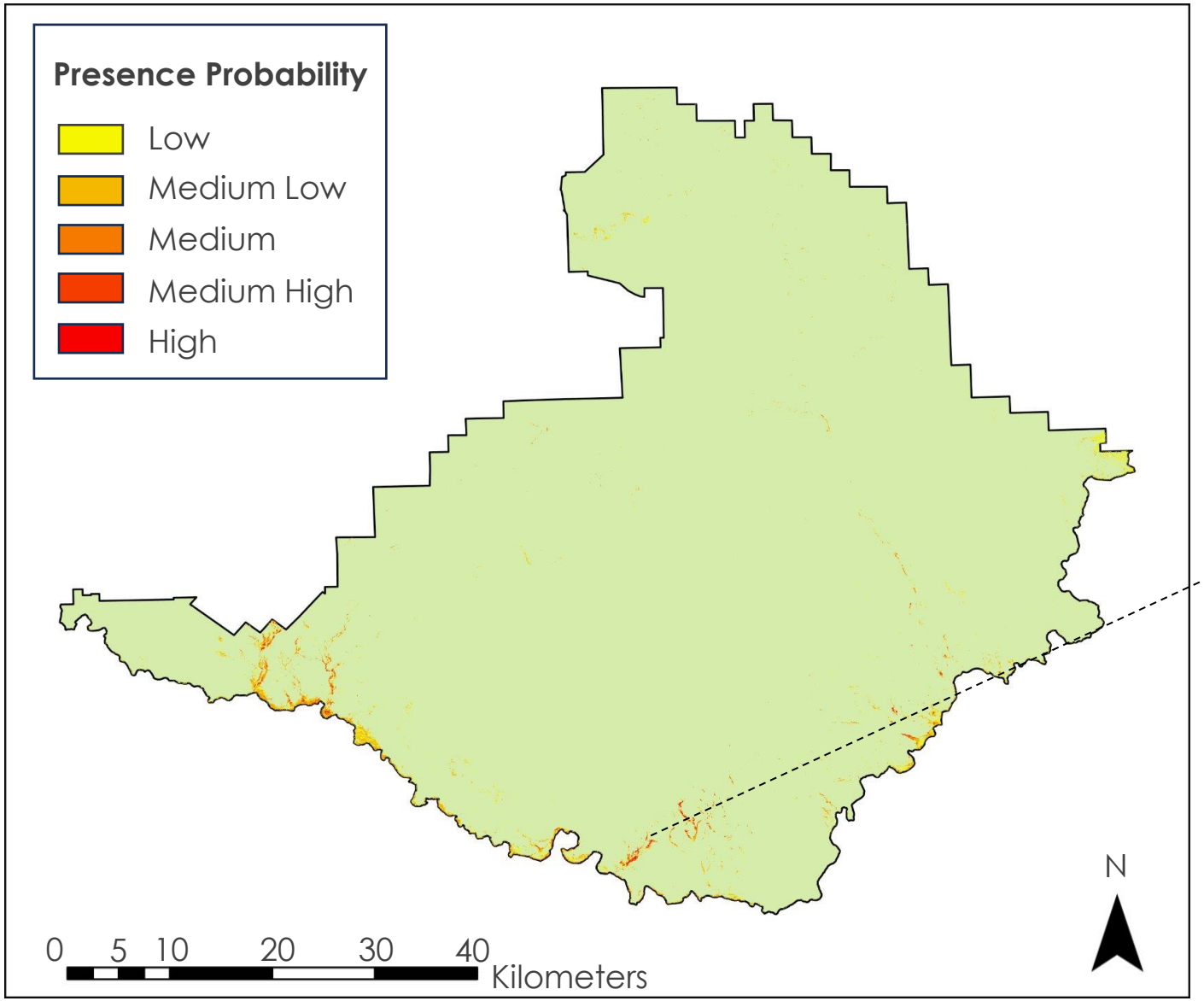
Zone	Habitat Suitability Statistic	Habitat Suitability Rank
1	0.3703	9
2	0.3956	7
3	0.3578	10
4	0.4064	5
5	0.3005	17
6	0.2397	20
7	0.3229	13
8	0.4967	2
9	0.3233	12
10	0.3094	16
11	0.3573	11
12	0.3222	14
13	0.2695	19
14	0.3166	15
15	0.4800	3
16	0.3961	6
17	0.4317	4
18	0.3869	8
19	0.5218	1
20	0.2757	18

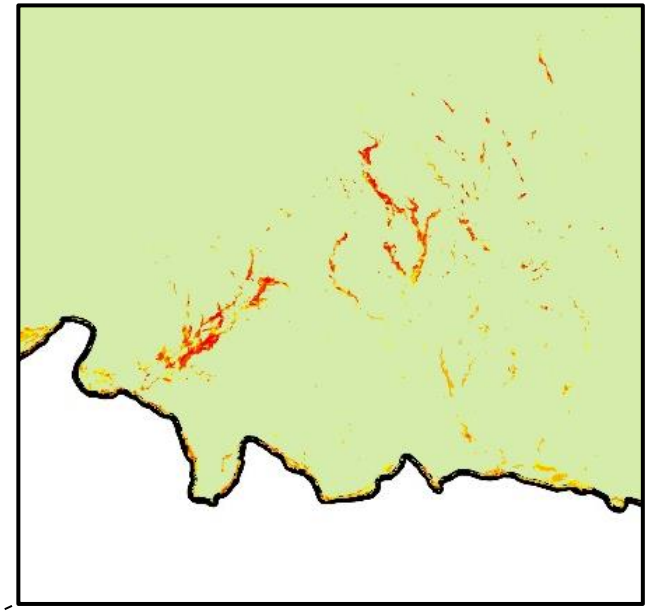
Fire Risk Assessment Results



Zone	Fire Risk Assessment	Fire Risk Assessment Rank
1	0.2453	18
2	0.3108	12
3	0.2294	19
4	0.3572	7
5	0.2685	16
6	0.2854	13
7	0.3668	6
8	0.6310	2
9	0.2810	14
10	0.6567	1
11	0.3326	8
12	0.2593	17
13	0.3115	11
14	0.2769	15
15	0.3286	9
16	0.3151	10
17	0.3745	4
18	0.3691	5
19	0.4877	3
20	0.2278	20

Buffelgrass Detection Results

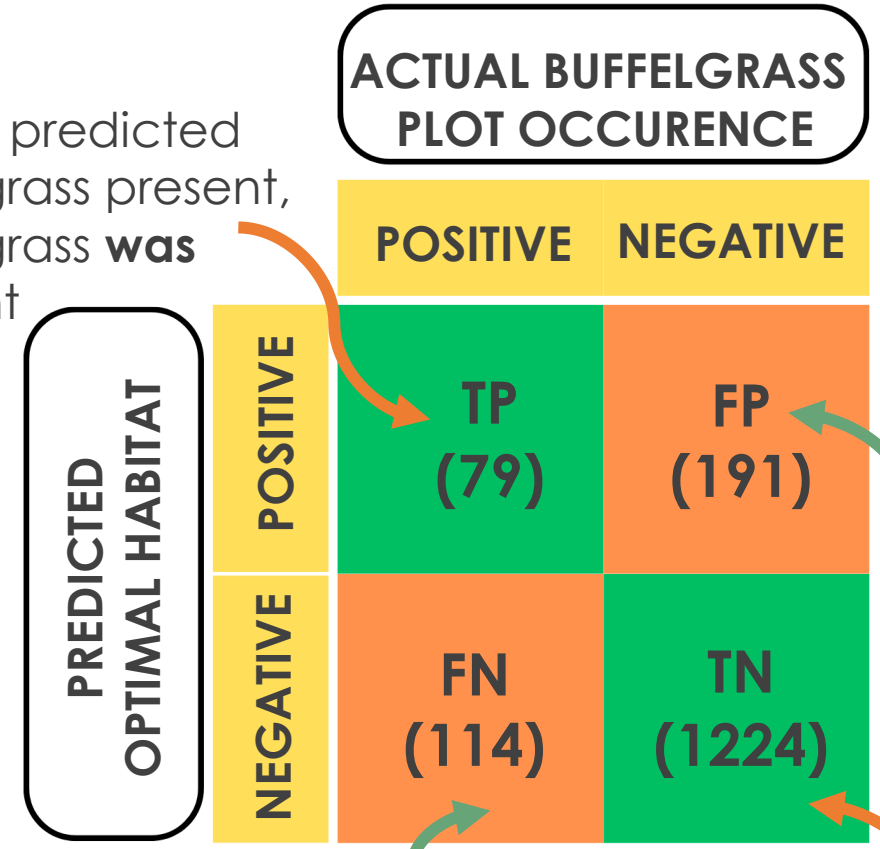




8 Year Analysis

- Areas identified with three or more years of combined green-ups
- Validated using in situ data
- Visible for optimal habitat suitability

Confusion Matrix



Model predicted Buffelgrass present, Buffelgrass **was** present

Model predicted Buffelgrass present, **no** Buffelgrass was present

Model predicted Buffelgrass absent, Buffelgrass **was** present

Model predicted Buffelgrass absent, **no** Buffelgrass was present

$$\frac{TP + TN}{TOTAL\ SUM}$$

Errors, Uncertainties & Limitations

- **Co-dominant species** and habitable, **visible vegetation** was cut off at **2% correlation**
- **Precipitation** and **temperature** data collected through **four weather stations** at different elevations
- Last known **In Situ data** for Buffelgrass was collected in **2018**
- **Time** limitations and **accessibility** to commercial satellite imagery
- Lack of **NDVI data** for far west corner of the park

Big Bend National Park
Image Credit: National Park Service

Future Work

- Using a collaboration of **drone collected data** as well as **ground surveys** to confirm analytics and results
- Incorporating **multi spectral satellite data** to calibrate our model to locate Buffelgrass more preciously
- Applying these models to other **invasive perineal grass species** to address environmental and safety concerns in the park

Big Bend National Park
Image Credit: National Park Service

Conclusion

- **Created** park zones that allowed for a systematic method of analysis for calculating habitat suitability and fire risk
- **Performed** a comprehensive habitat suitability and fire risk assessment which prioritized mitigation and management efforts for Big Bend National Park
- **Combined** multi-source land image phenology data with optimal habitat suitability to generate a species detection map with 81% overall accuracy

Big Bend National Park
Image Credit: National Park Service

Acknowledgments

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