



Using Object-Based Image Analysis to Map Alpine Tundra on Mount Mansfield, Vermont

Cale Kochenour | GEOG 596A | October 24, 2018

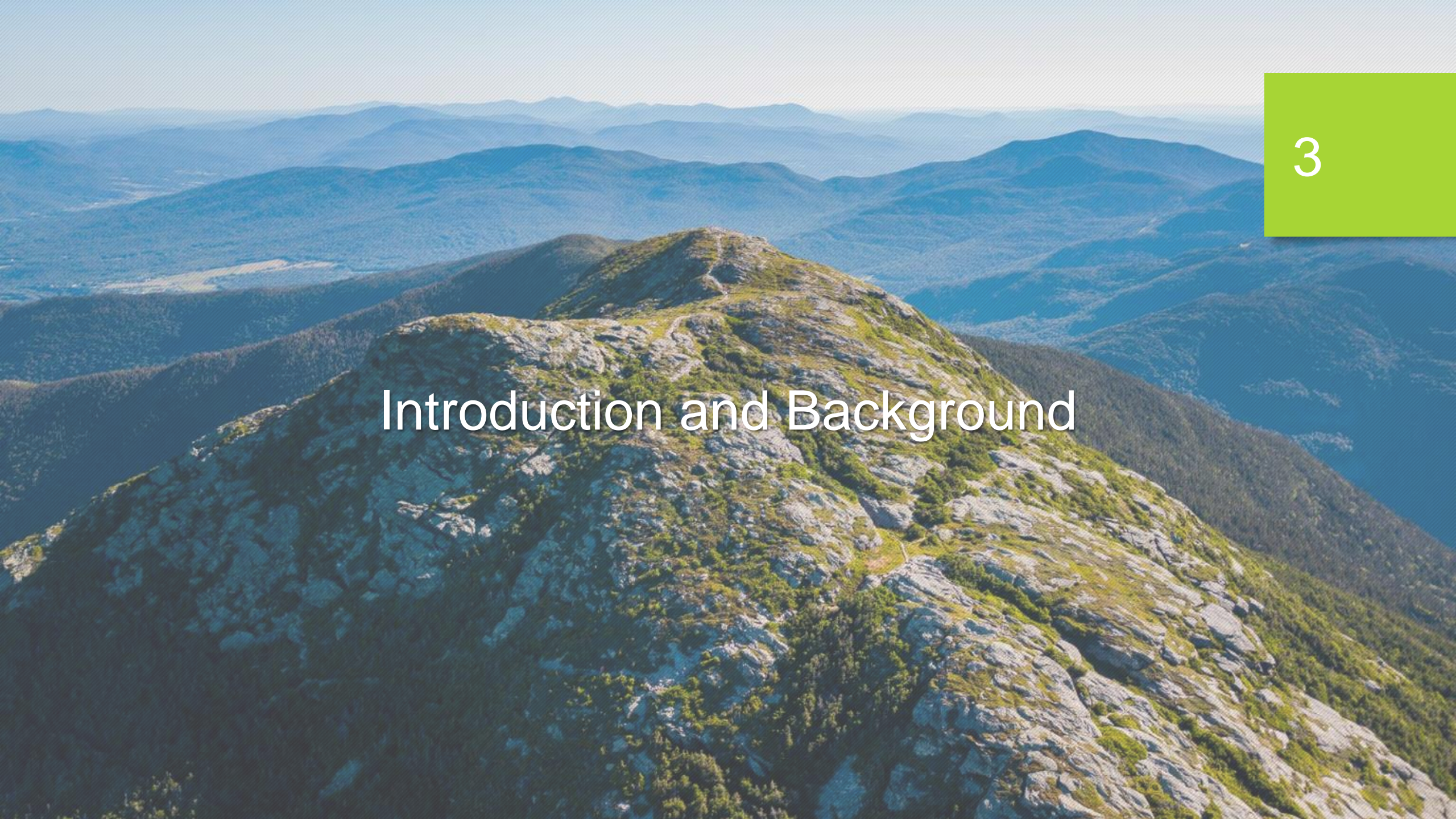
The Pennsylvania State University | Advisor: Jarlath O'Neil-Dunne

Agenda

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- Introduction and Background
- Land Cover Classification
- Project Workflow
- Image Interpretation Key
- Project Logistics

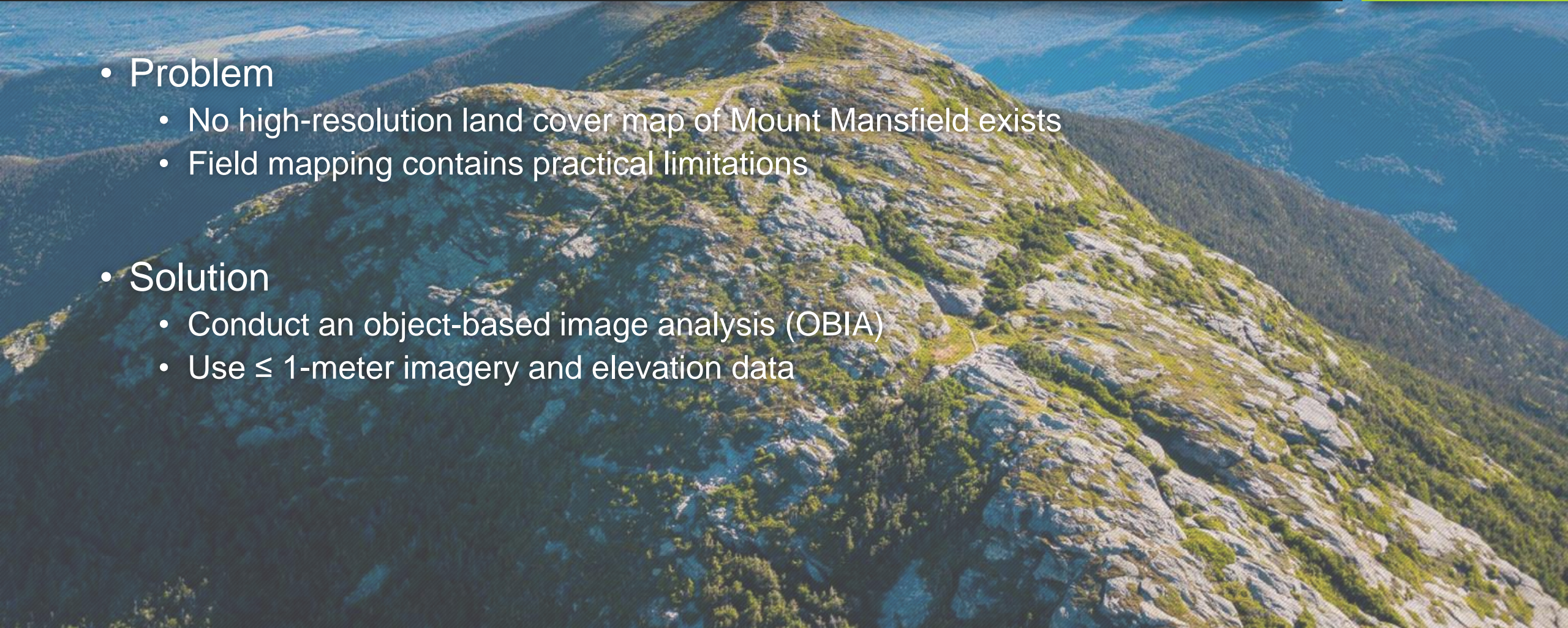
Introduction and Background



Problem and Proposed Solution

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- Problem
 - No high-resolution land cover map of Mount Mansfield exists
 - Field mapping contains practical limitations
- Solution
 - Conduct an object-based image analysis (OBIA)
 - Use ≤ 1 -meter imagery and elevation data



Background

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- National Land Cover Database (NLCD) 2011
 - Pixel-based
 - 30-meter spatial resolution
 - Does not capture the size, shape, or spatial arrangement of features
- Field Mapping Challenges
 - Seasonal snow cover
 - Restricted areas
 - Steep slopes and minimal trails

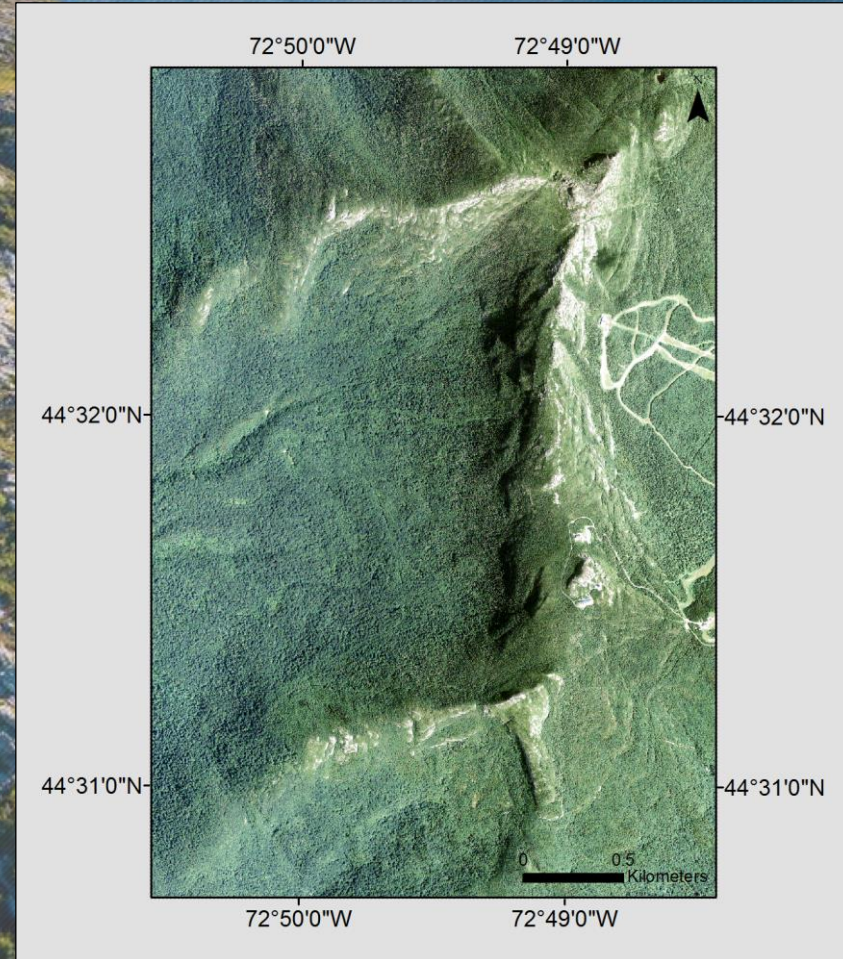
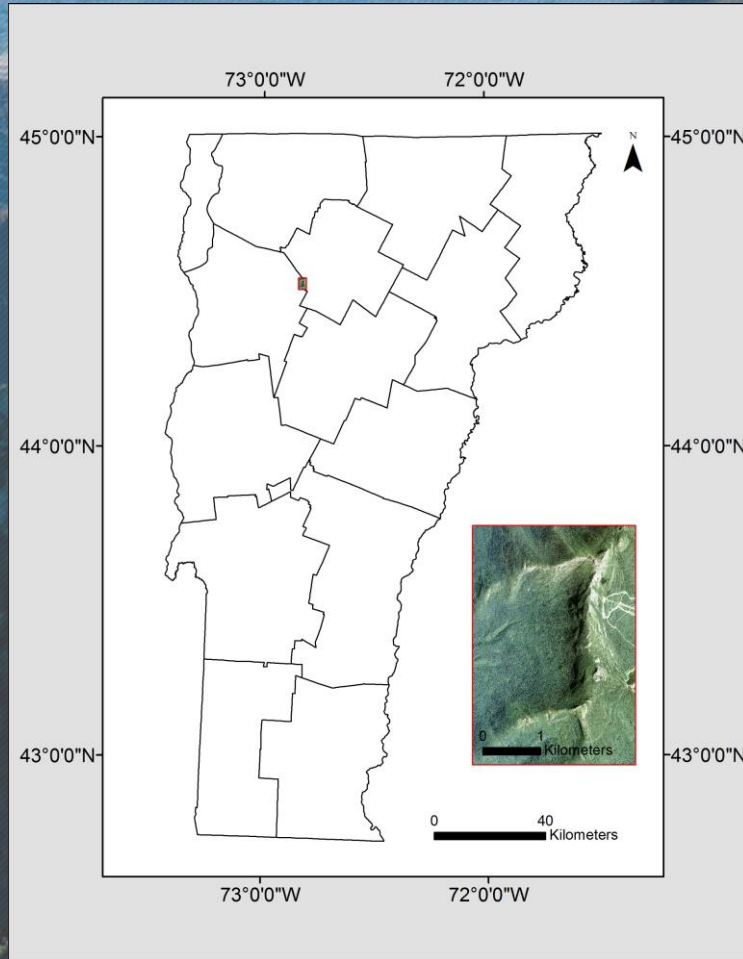
Solution Impacts

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- Benefits
 - Creates a baseline land cover map
 - Usable by local stakeholders
 - Cost and schedule-efficient
- Applications
 - Estimate the area of alpine tundra
 - Establish a baseline for change detection
 - Incorporate into future GIS and remote sensing studies

Study Area Overview

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Features of Interest

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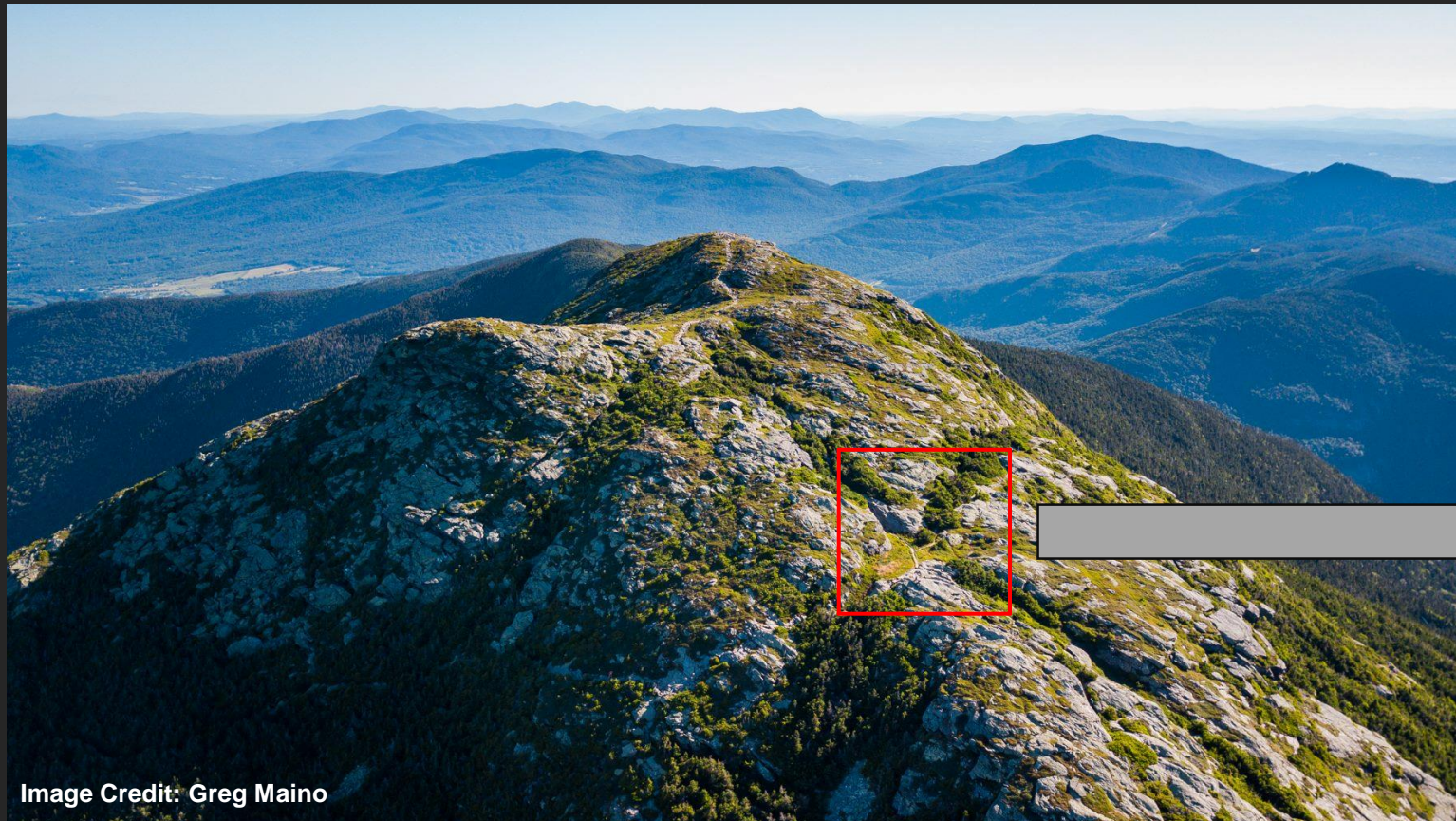
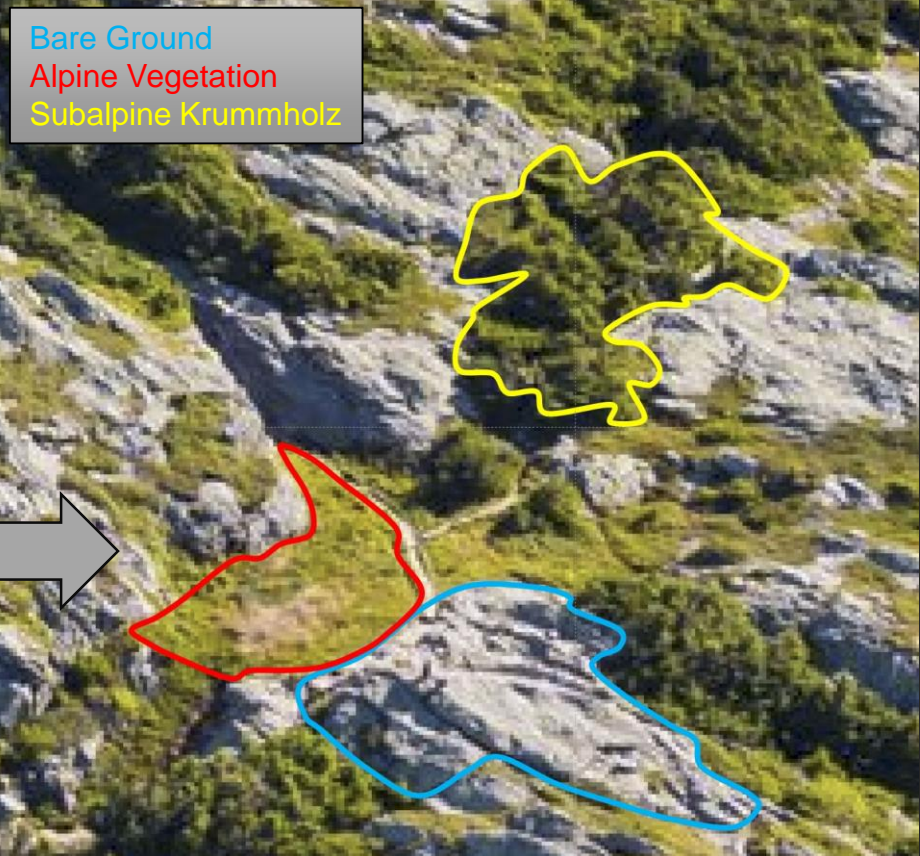


Image Credit: Greg Maino








Land Cover Classification

NLCD 2011 Classes on Mount Mansfield

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- Auto Road/Visitor Center
 - 21 – Developed, Open Space
 - 22 – Developed, Low Intensity
 - 23 – Developed, Medium Intensity
- Forest Canopy
 - 42 – Evergreen Forest
 - 43 – Mixed Forest
- Tundra
 - 31 – Barren Land (Rock/Sand/Clay)
 - 52 – Shrub/Scrub
 - 71 – Grassland/Herbaceous

NLCD Land Cover Classification Legend

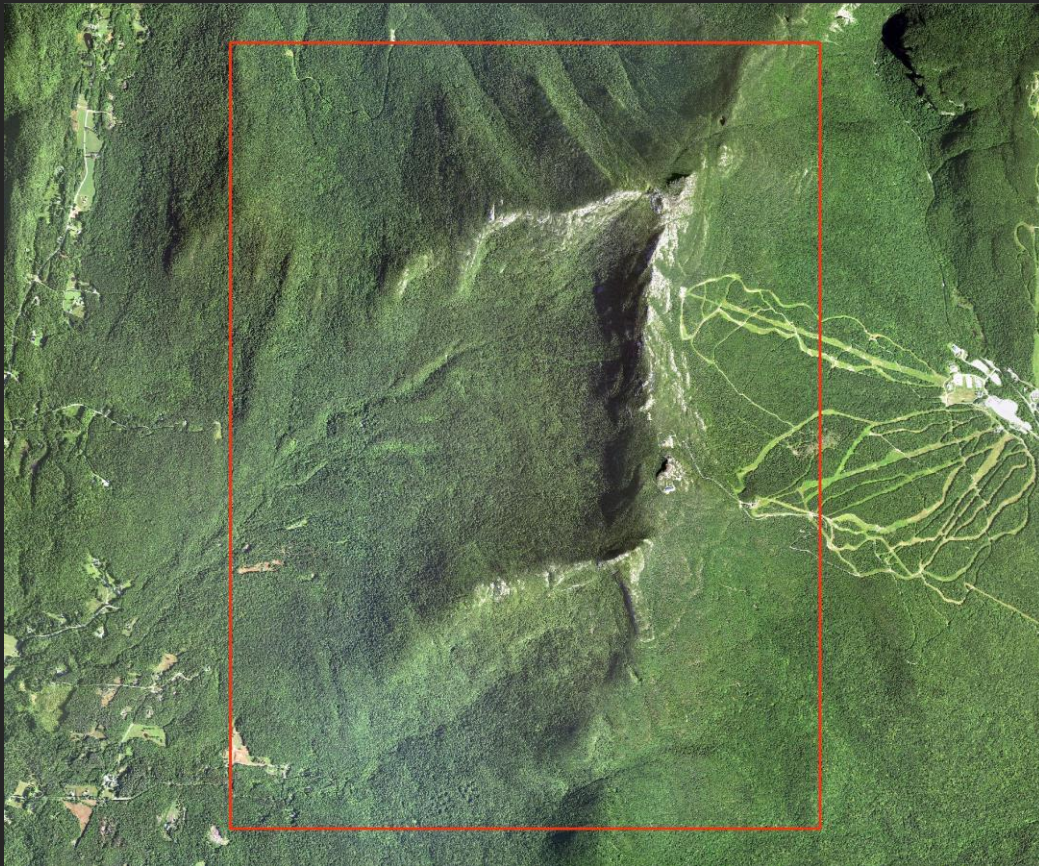
	11 Open Water
	12 Perennial Ice/ Snow
	21 Developed, Open Space
	22 Developed, Low Intensity
	23 Developed, Medium Intensity
	24 Developed, High Intensity
	31 Barren Land (Rock/Sand/Clay)
	41 Deciduous Forest
	42 Evergreen Forest
	43 Mixed Forest
	51 Dwarf Scrub*
	52 Shrub/Scrub
	71 Grassland/Herbaceous
	72 Sedge/Herbaceous*
	73 Lichens*
	74 Moss*
	81 Pasture/Hay
	82 Cultivated Crops
	90 Woody Wetlands
	95 Emergent Herbaceous Wetlands

* Alaska only

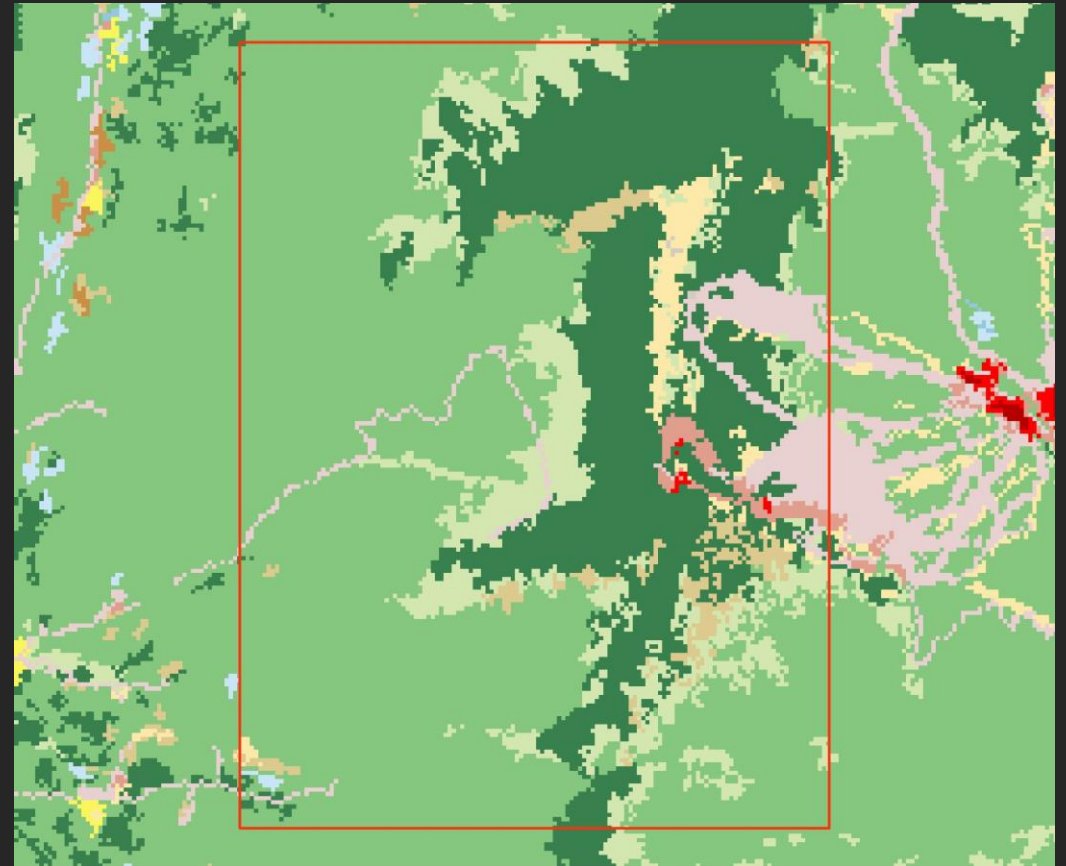
NLCD 2011 Mapping

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NAIP – 2016 – 0.6m



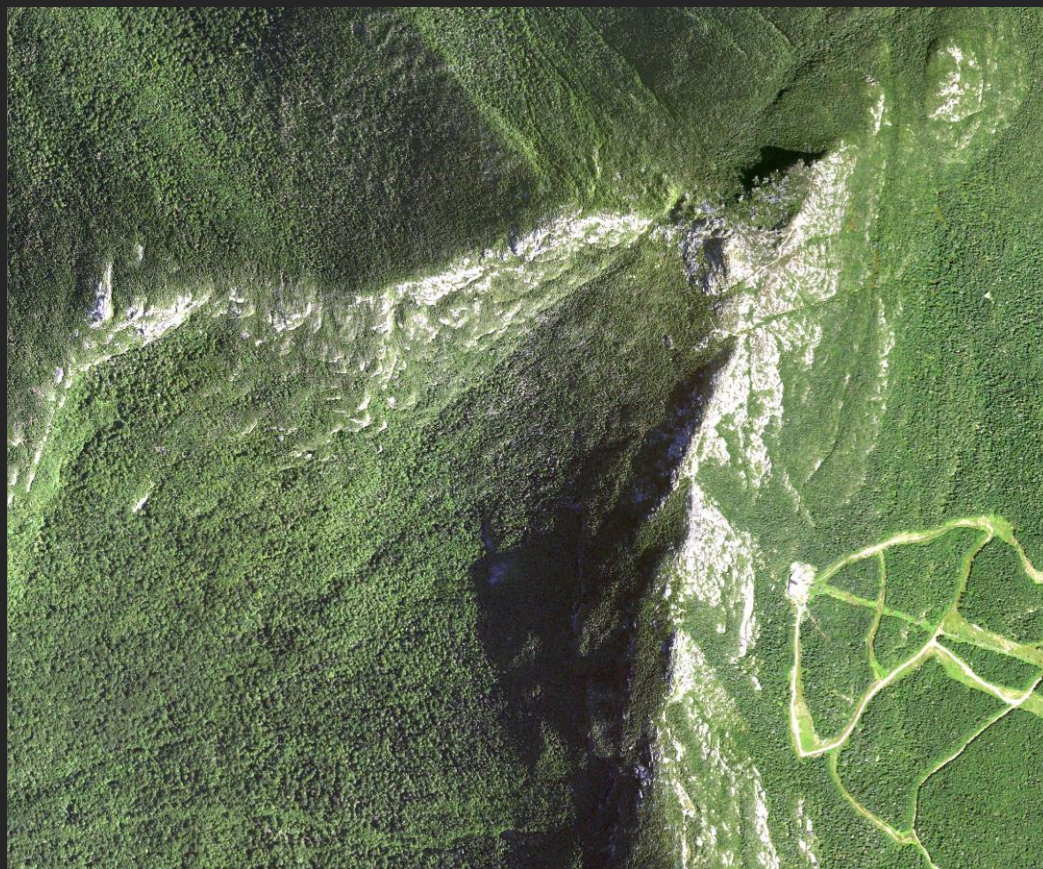
NLCD – 2011 – 30m



NLCD 2011 Mapping (cont.)

12

NAIP – 2016 – 0.6m



NLCD – 2011 – 30m



NLCD 2011 Mapping (cont.)

13

NAIP – 2016 – 0.6m



NLCD – 2011 – 30m



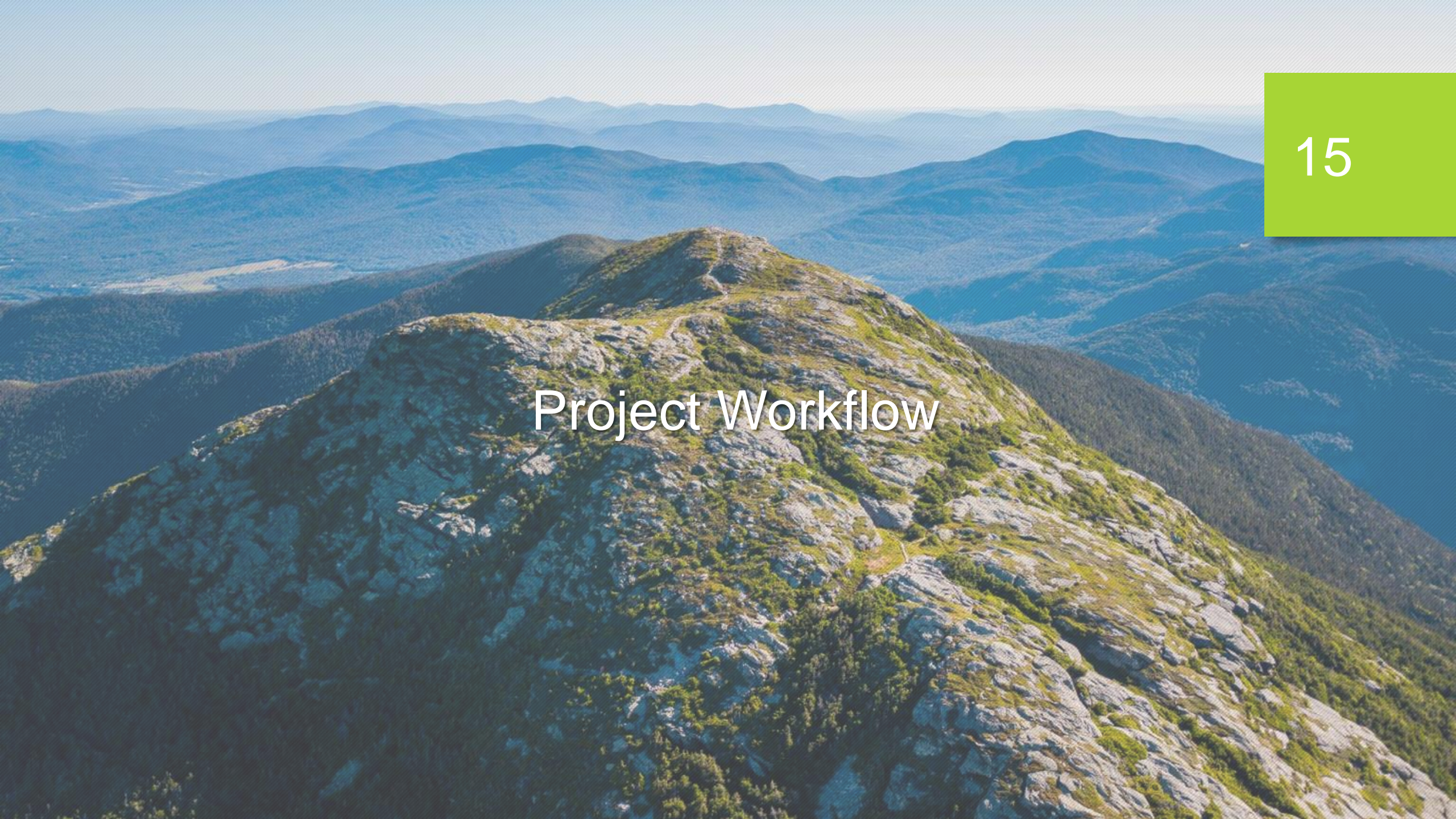
Proposed Classes

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- Features of Interest
 - Bare Ground
 - Alpine Vegetation
 - Subalpine Krummholz
- Other Features
 - Building
 - Radio/TV Tower
 - Auto Road/Parking Lot
 - Gravel Construction Road
 - Coniferous Tree
 - Deciduous Tree
 - Ski Trail
 - Car



Project Workflow



Data Acquisition

Imagery

Elevation

Data Preprocessing

Mosaic

Project

Clip

Band Combinations

DEM Derivatives

Data Processing

Segmentation

Classification

Export

Accuracy Assessment

Error Matrix

Kappa (KHAT)

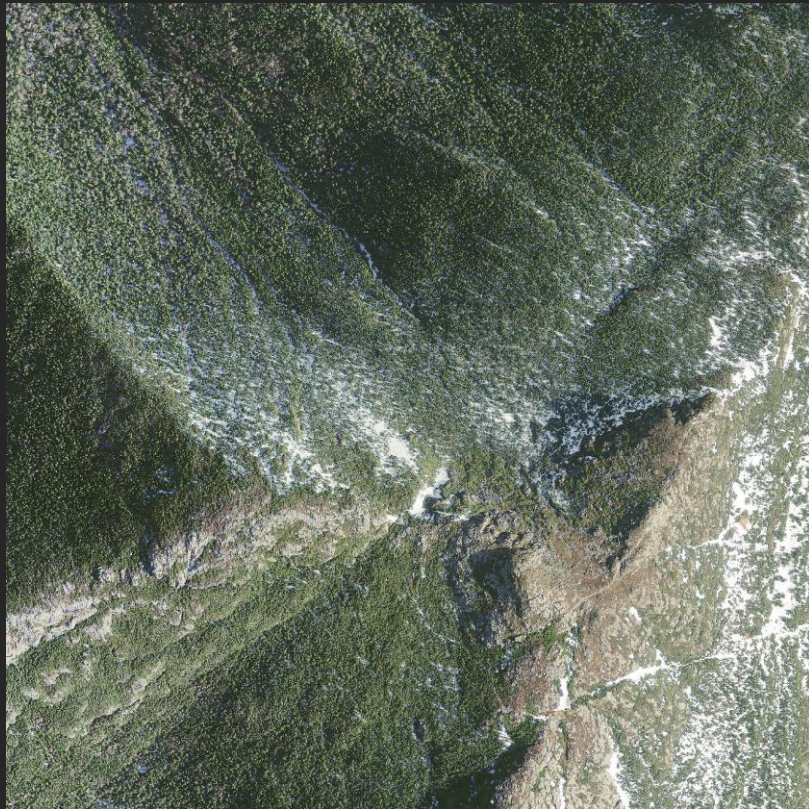
Data Acquisition

The screenshot shows the Vermont Open Geodata Portal website. At the top, there is a dark green header with the text "VERMONT OFFICIAL STATE WEBSITE" on the left and the Vermont state logo with the word "VERMONT" on the right. Below this is a light green navigation bar containing the text "STATE OF VERMONT" and "Vermont Open Geodata Portal" in a larger font. To the right of the portal name are several menu items: "DATA", "WEB SERVICES", "APPLICATIONS", "DEVELOPERS", "CONTACT US", and "HELP". A "Sign In" link is located in the bottom right corner of this navigation bar. The main content area features a large satellite map of Vermont with a search bar overlaid in the center that says "Search for data" and has a magnifying glass icon. Below the map is a white horizontal bar with five icons and their corresponding labels: a tractor icon for "Agriculture", a grid of four map corner icons for "Basemap", a square with a circle and four dots for "Boundaries", a sun behind a cloud with rain for "Climate", and a group of three stylized people for "Demographic + Economic".

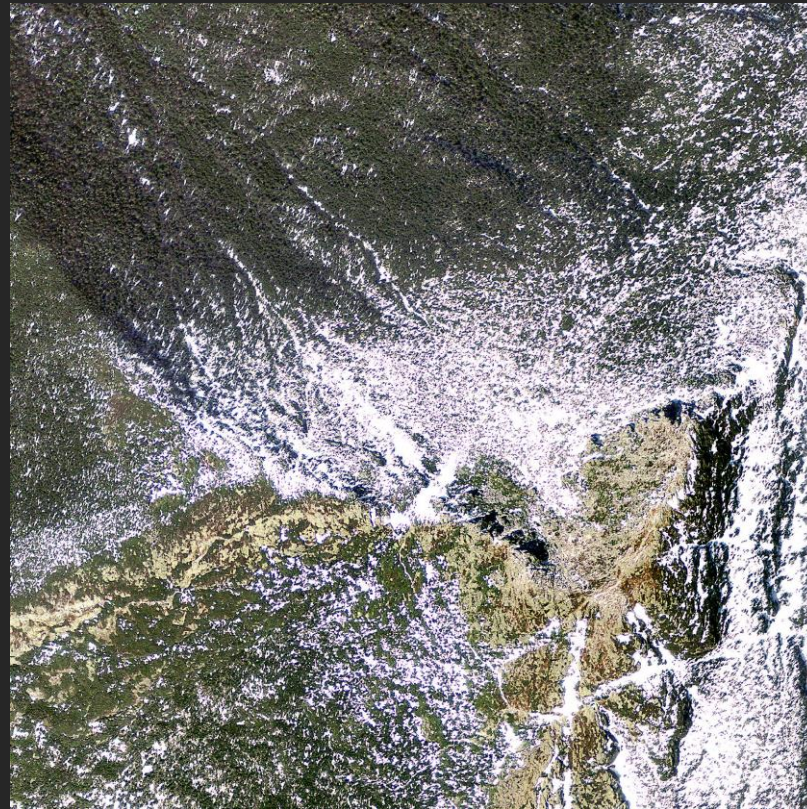
Imagery

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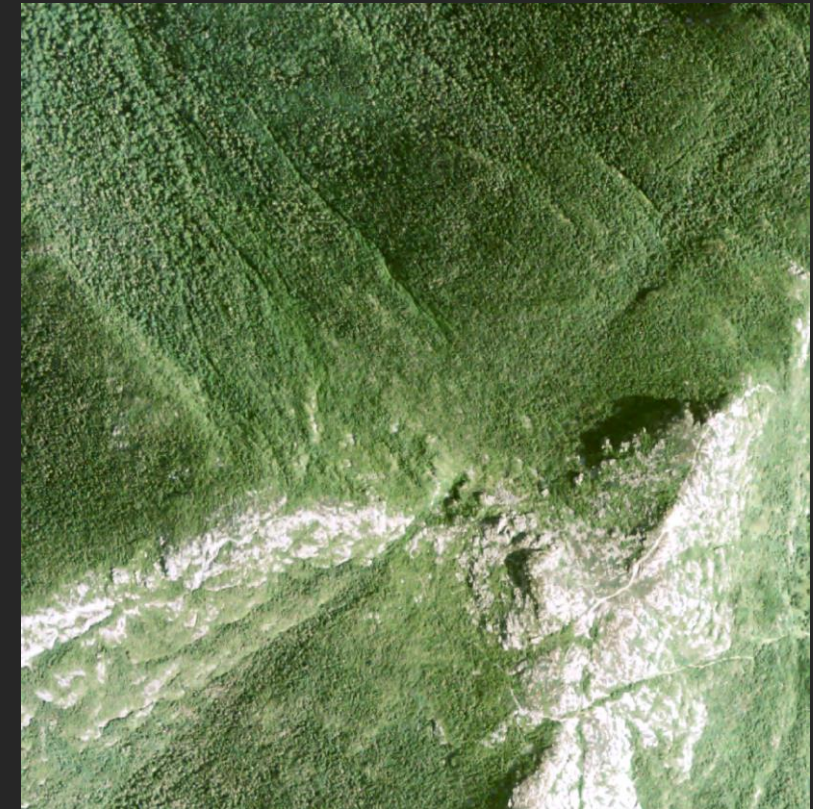
Chittenden - 2013 - 0.2 Meter



Northwestern VT - 2013 - 0.5 Meter



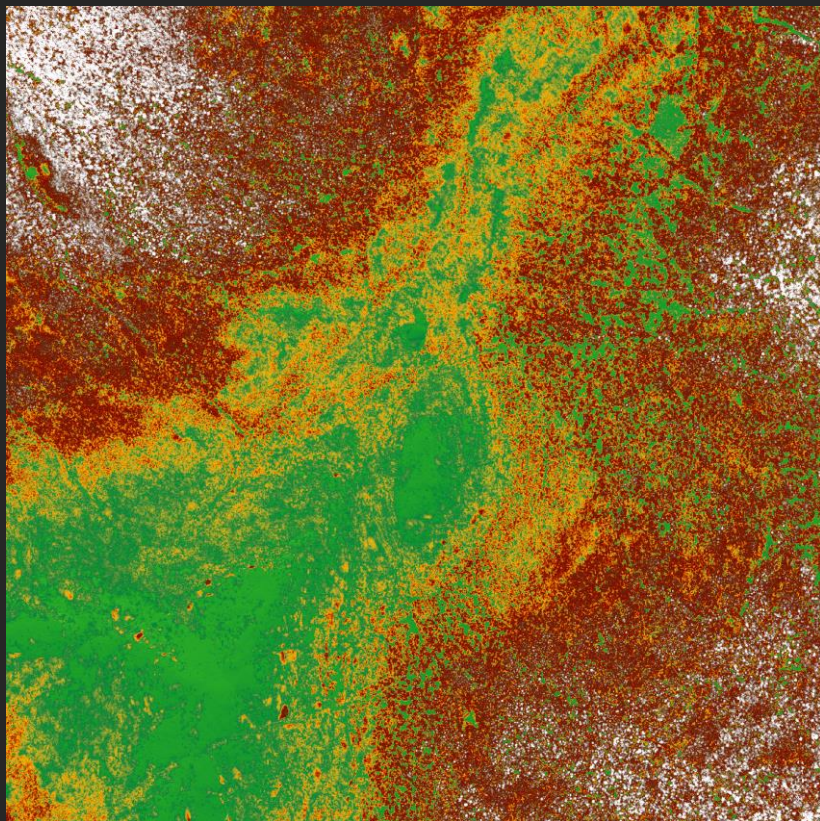
NAIP - 2014 - 1 Meter



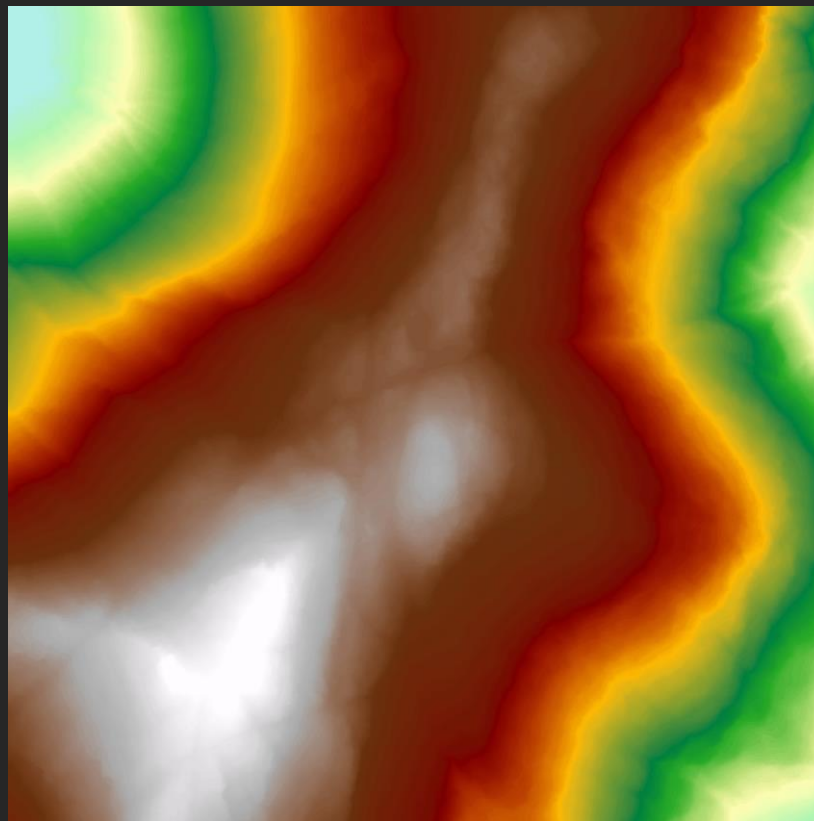
Elevation Data

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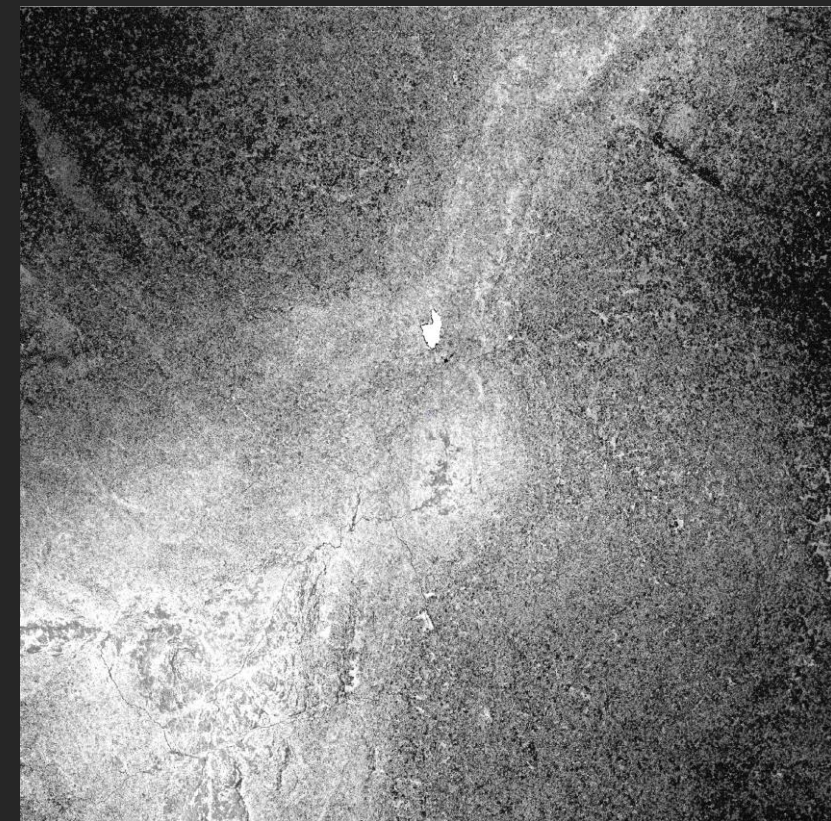
Normalized Digital Surface Model



Digital Elevation Model



Intensity



Proposed Software Packages

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- ArcGIS Desktop 10.x / ArcGIS Pro 2.x
- eCognition Developer 9.x
- LP360

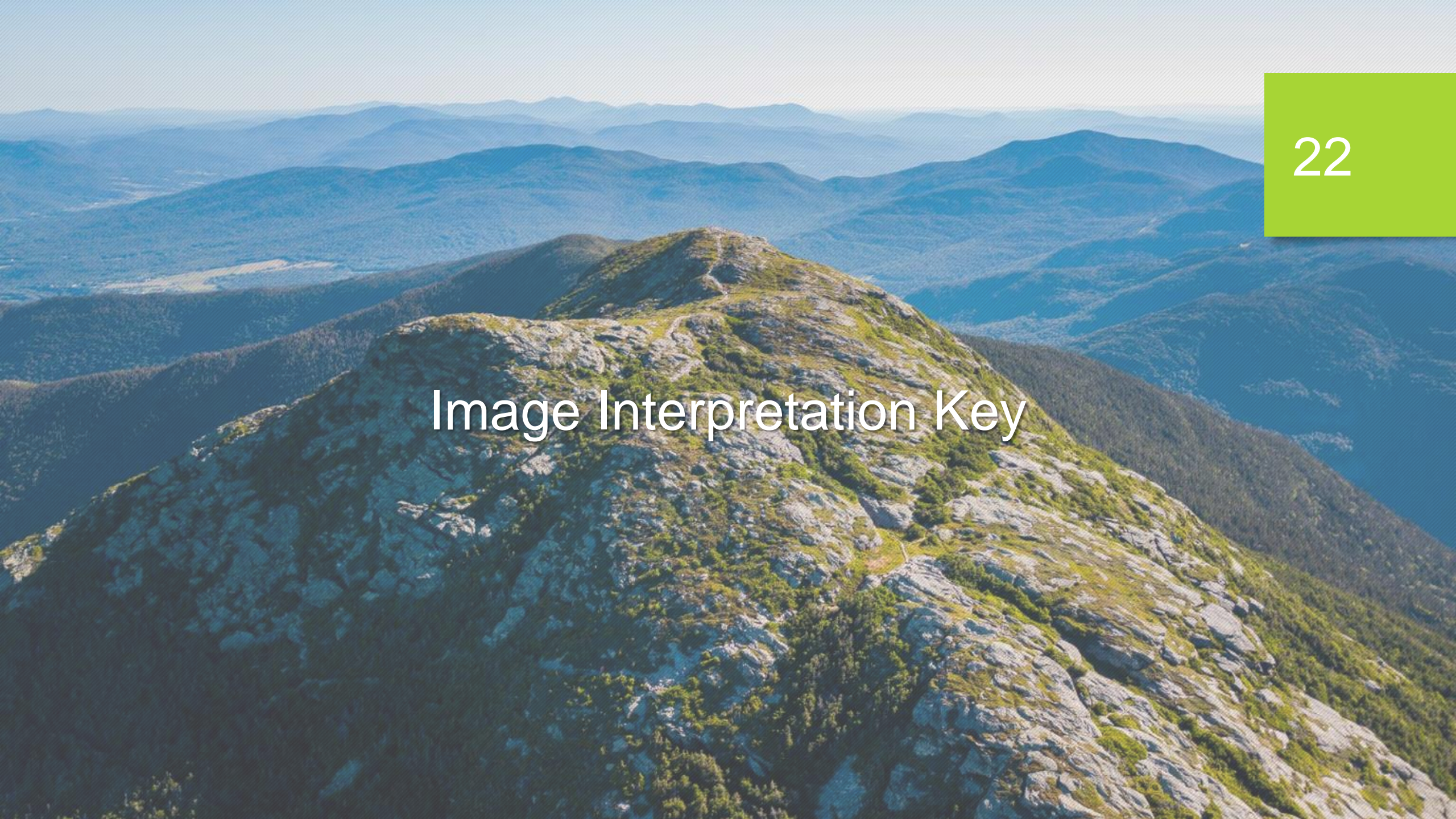
Accuracy Assessment

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- Error Matrix
 - Stratified random sampling approach
 - 100 reference points per mapped class
- Accuracy Measurements
 - Overall, User's, Producer's, Kappa (KHAT)

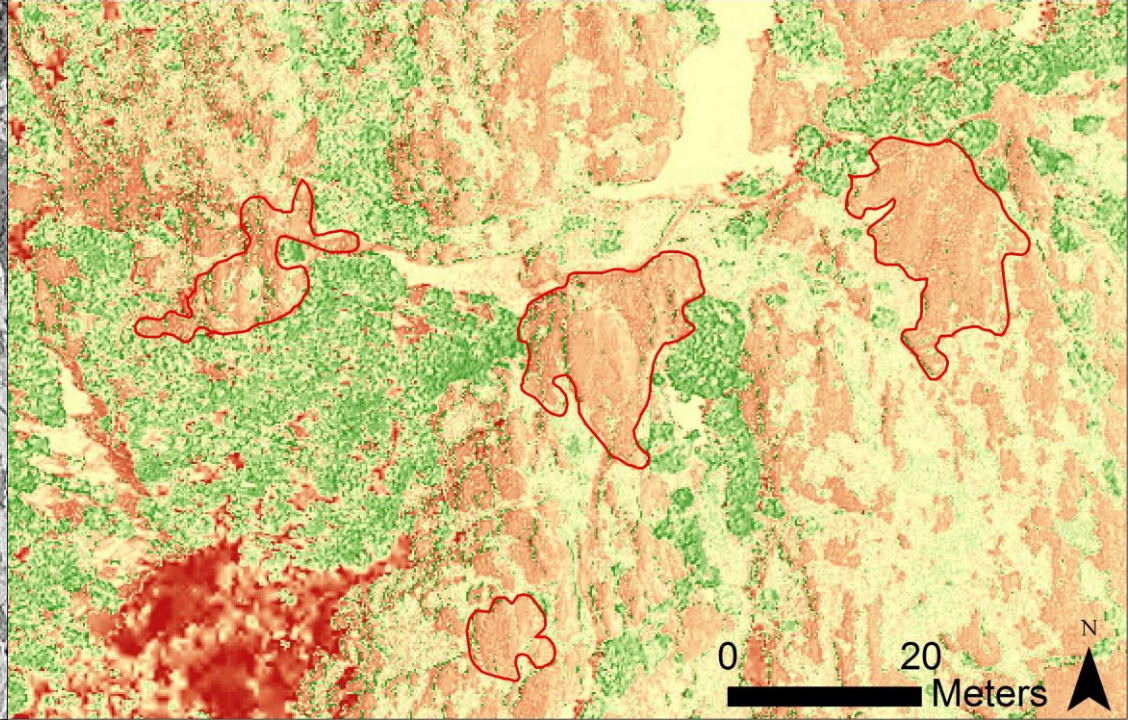
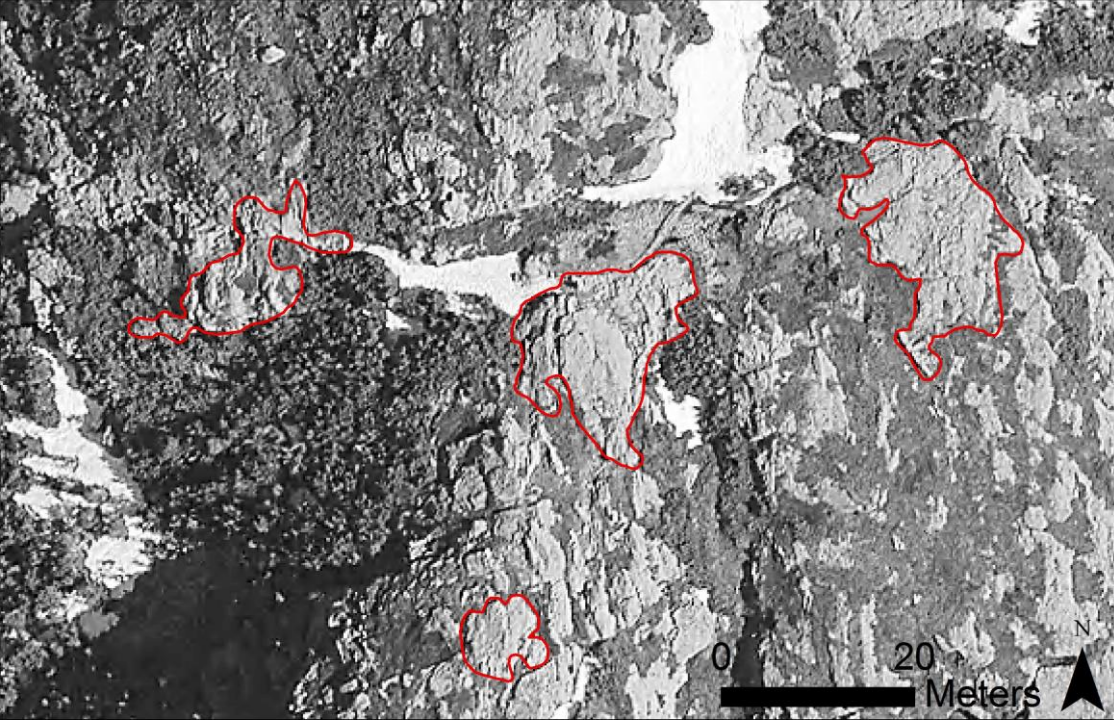
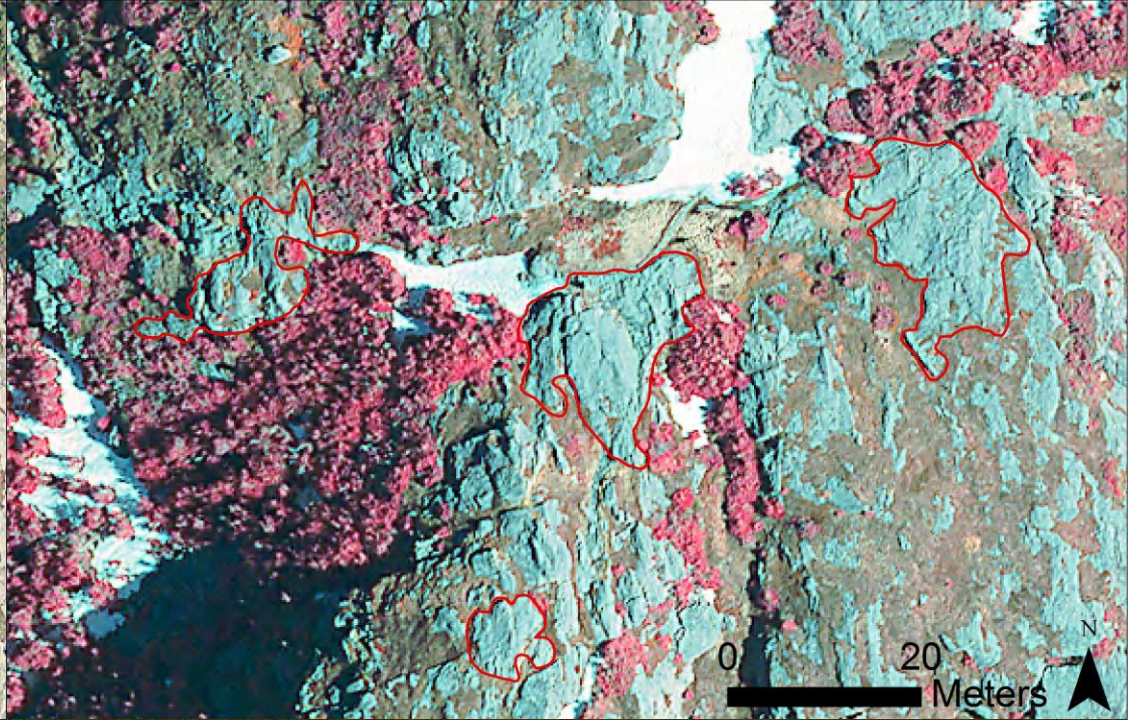
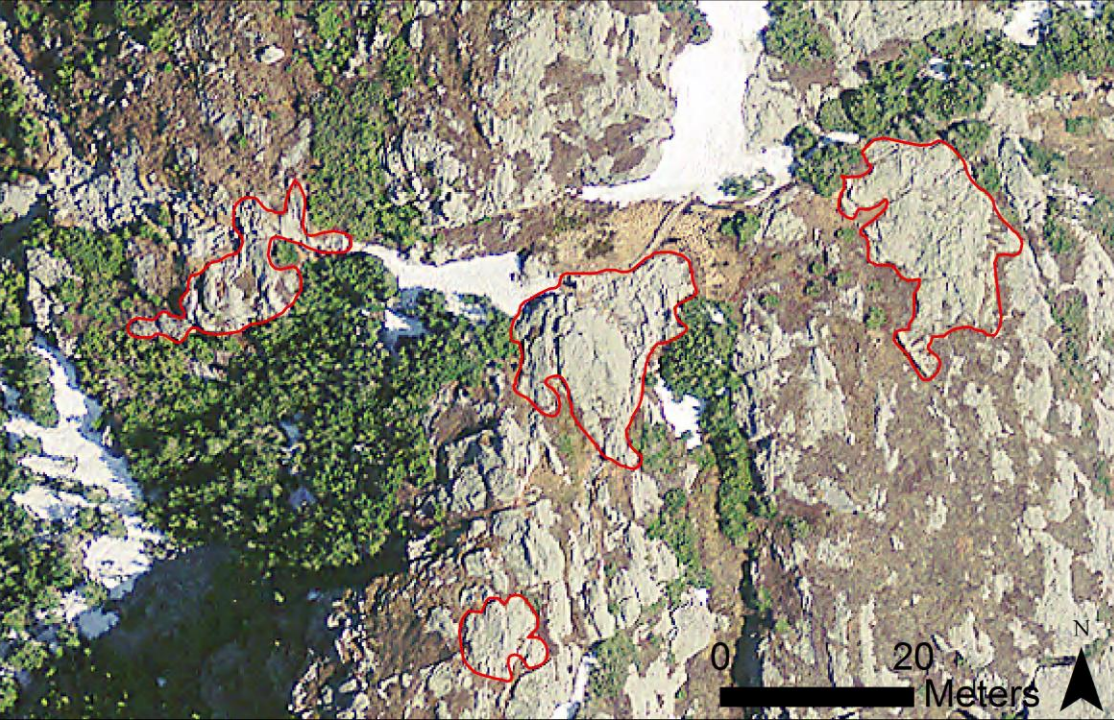
		Reference Data			Row Total	User's Accuracy
		Bare Ground	Alpine Vegetation	Krummholz		
Classified Data	Bare Ground					0.00%
	Alpine Vegetation					0.00%
	Krummholz					0.00%
Column Total						
Producer's Accuracy		0.00%	0.00%	0.00%		0.00%

Image Interpretation Key

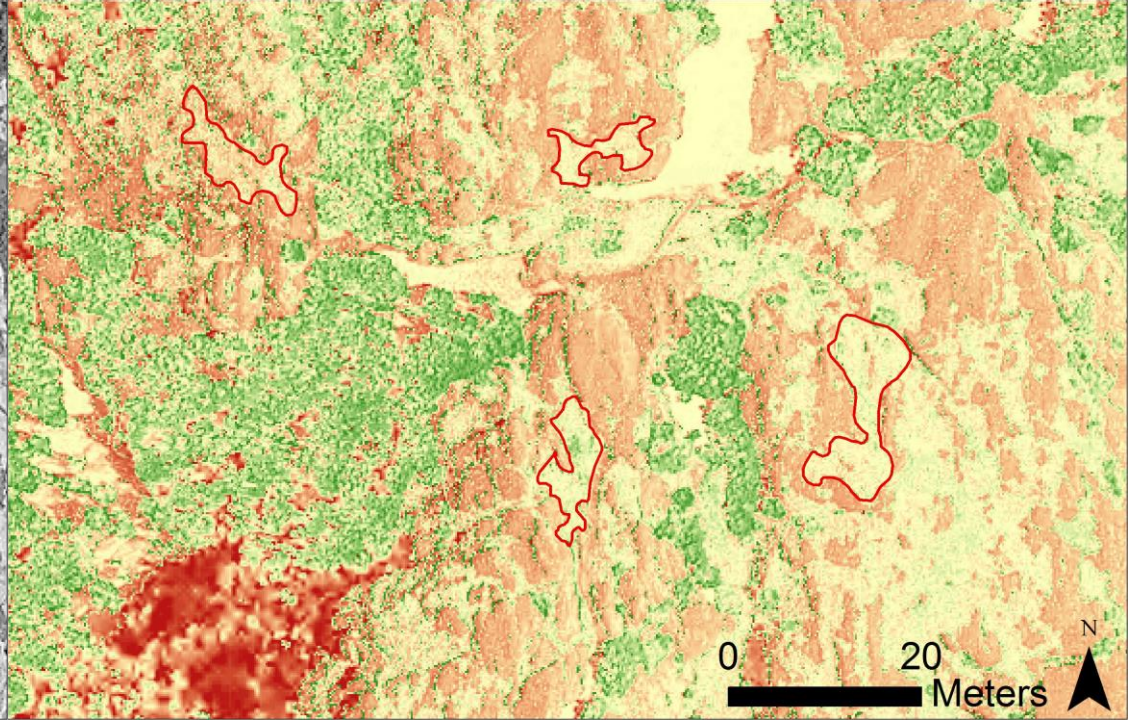
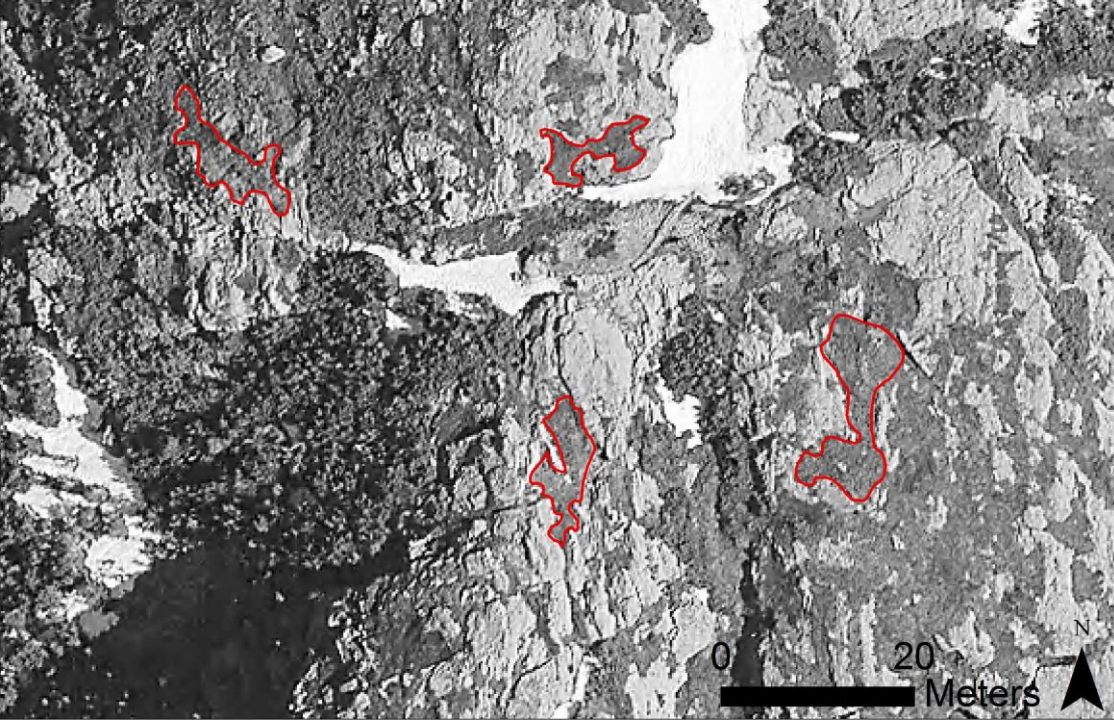
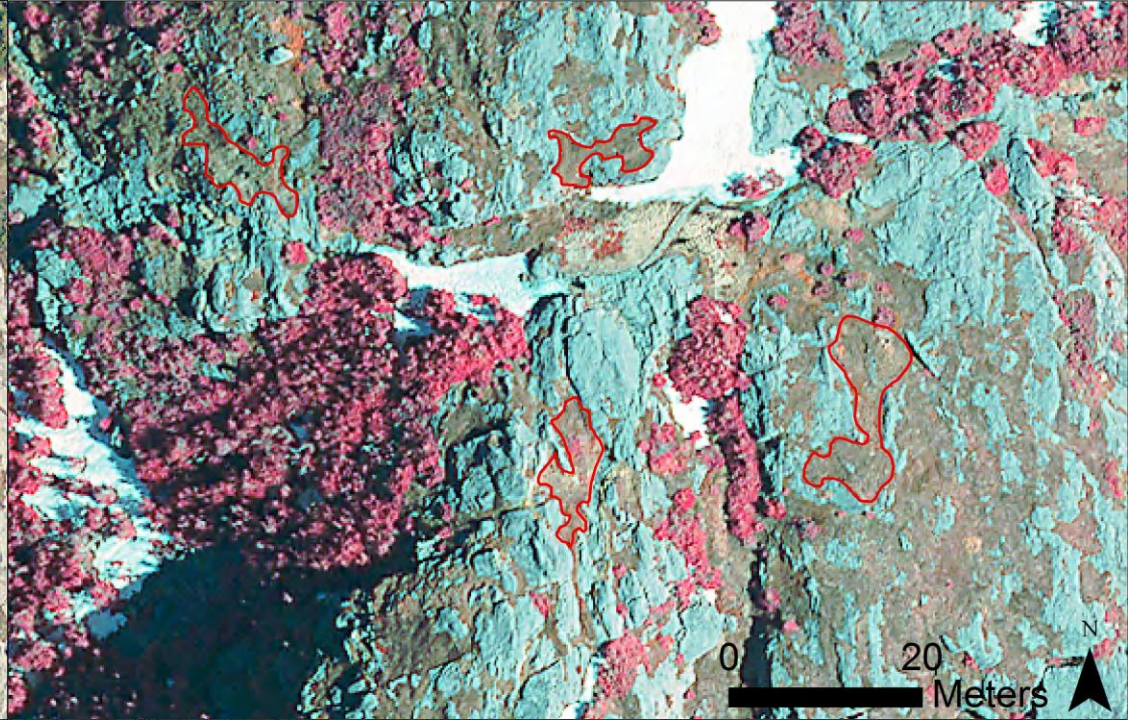
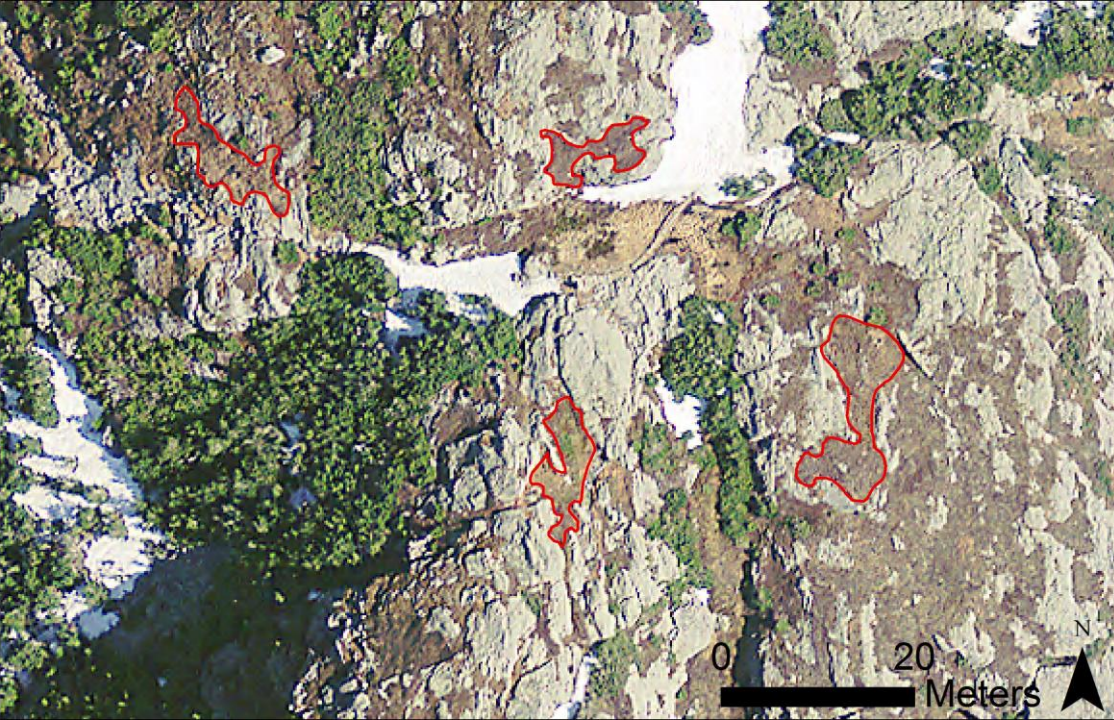


Leaf Off
Bare Ground
VT Imagery 0.2 meter

NW = True Color
NE = Color Infrared
SW = Panchromatic
SE = NDVI

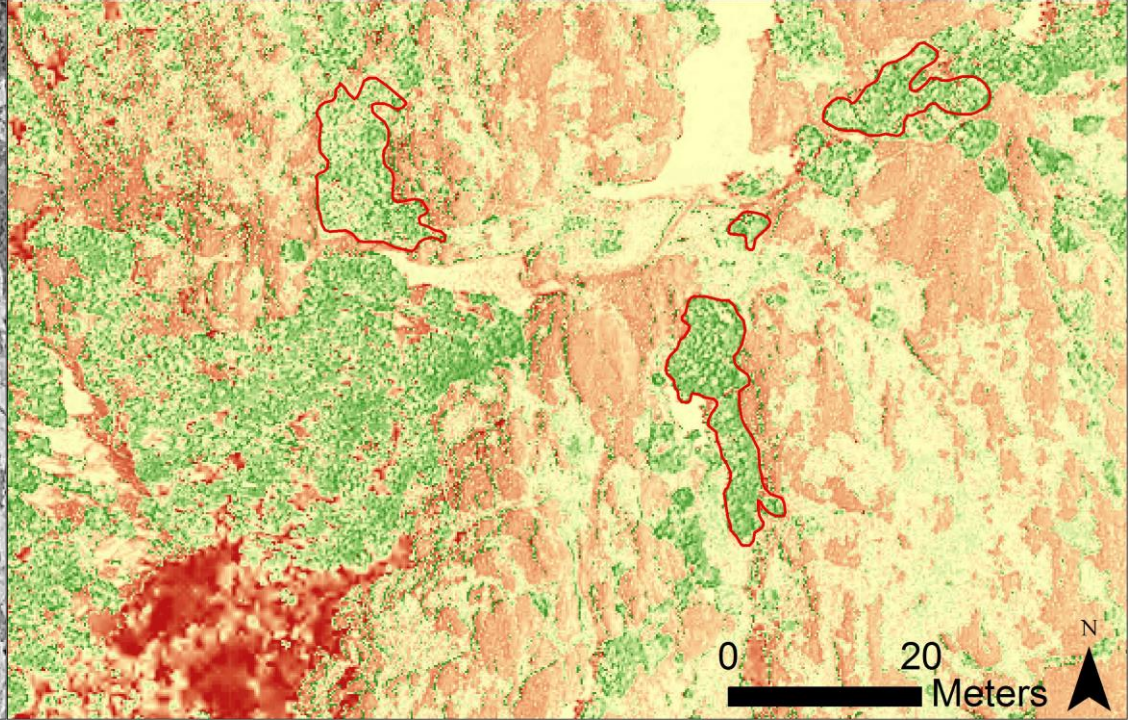
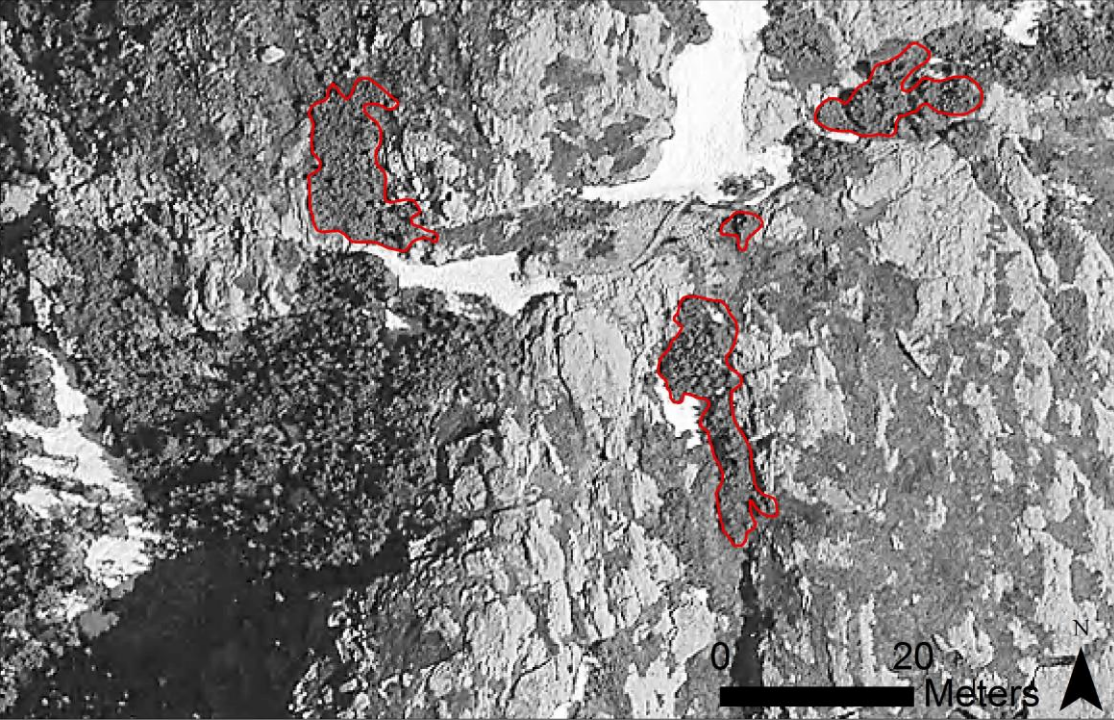
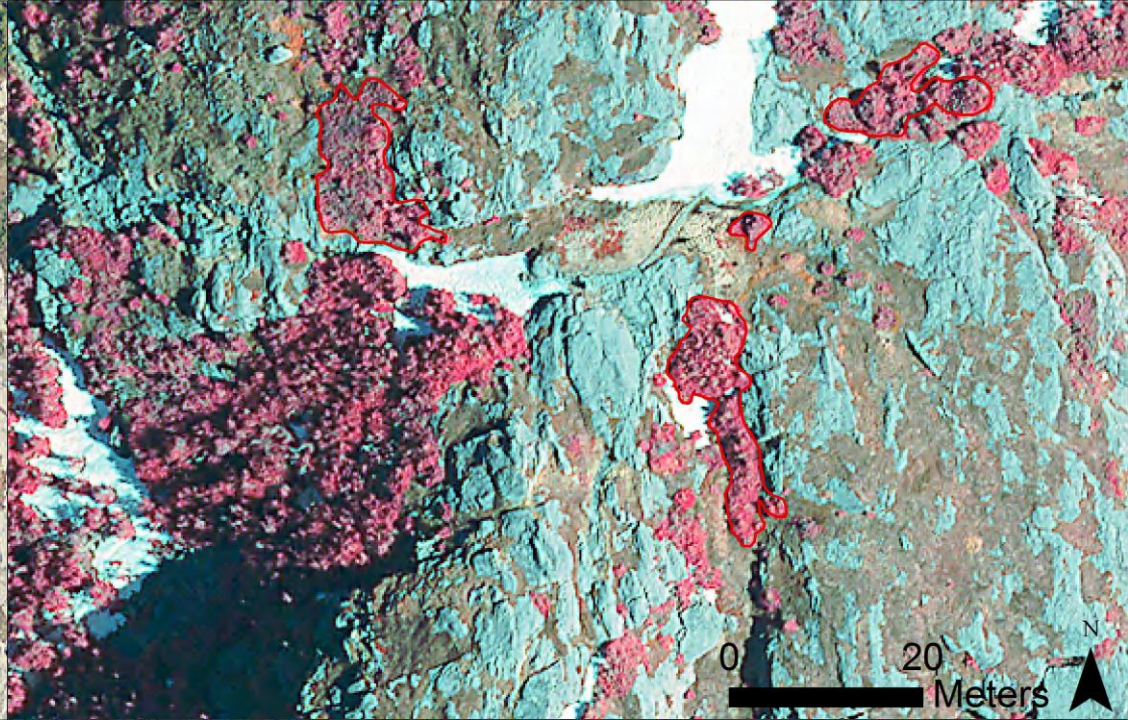


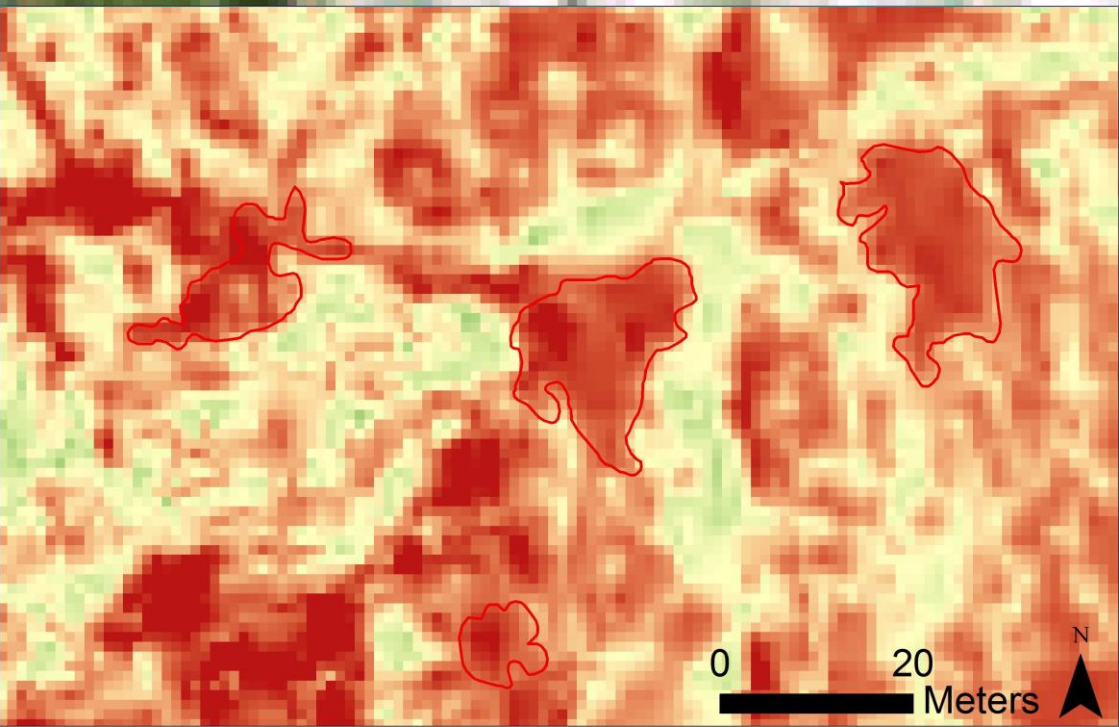
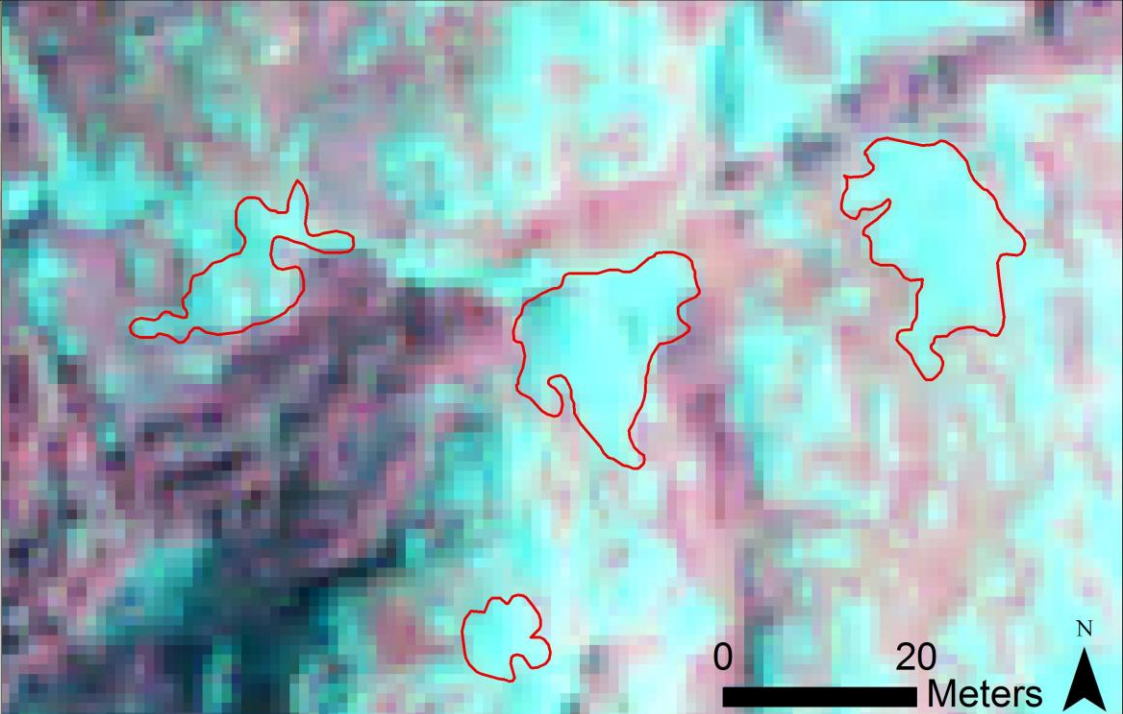
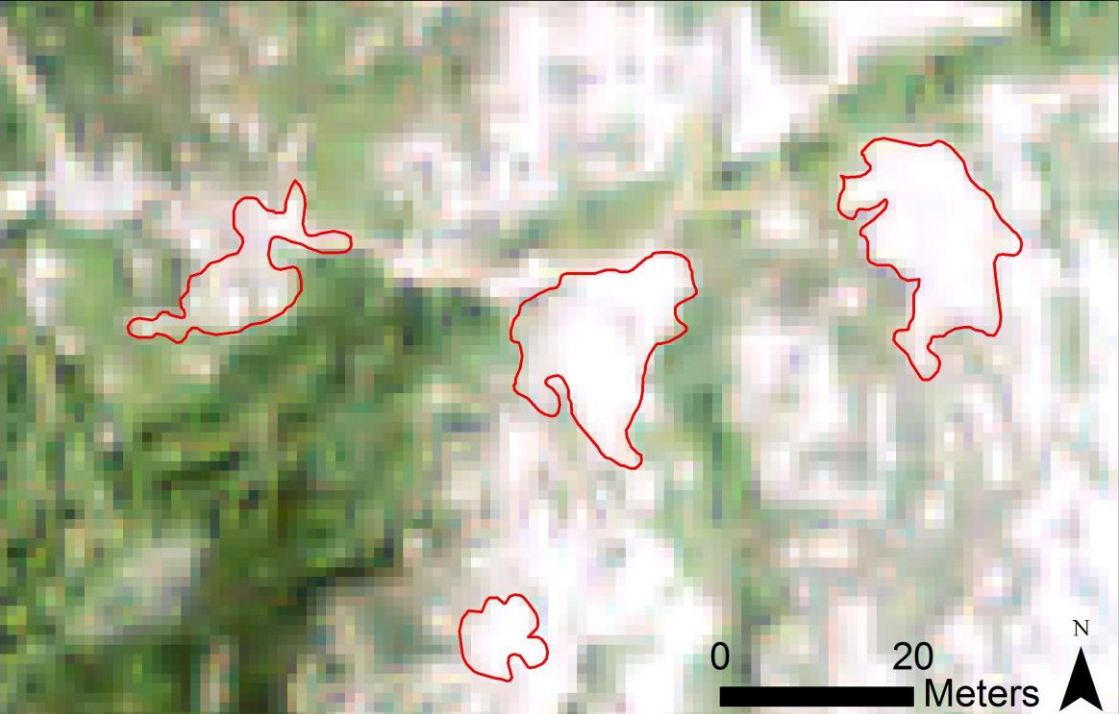
Leaf Off
Alpine Vegetation
VT Imagery 0.2 meter
NW = True Color
NE = Color Infrared
SW = Panchromatic
SE = NDVI



Leaf Off
Subalpine Krummholz
VT Imagery 0.2 meter

NW = True Color
NE = Color Infrared
SW = Panchromatic
SE = NDVI



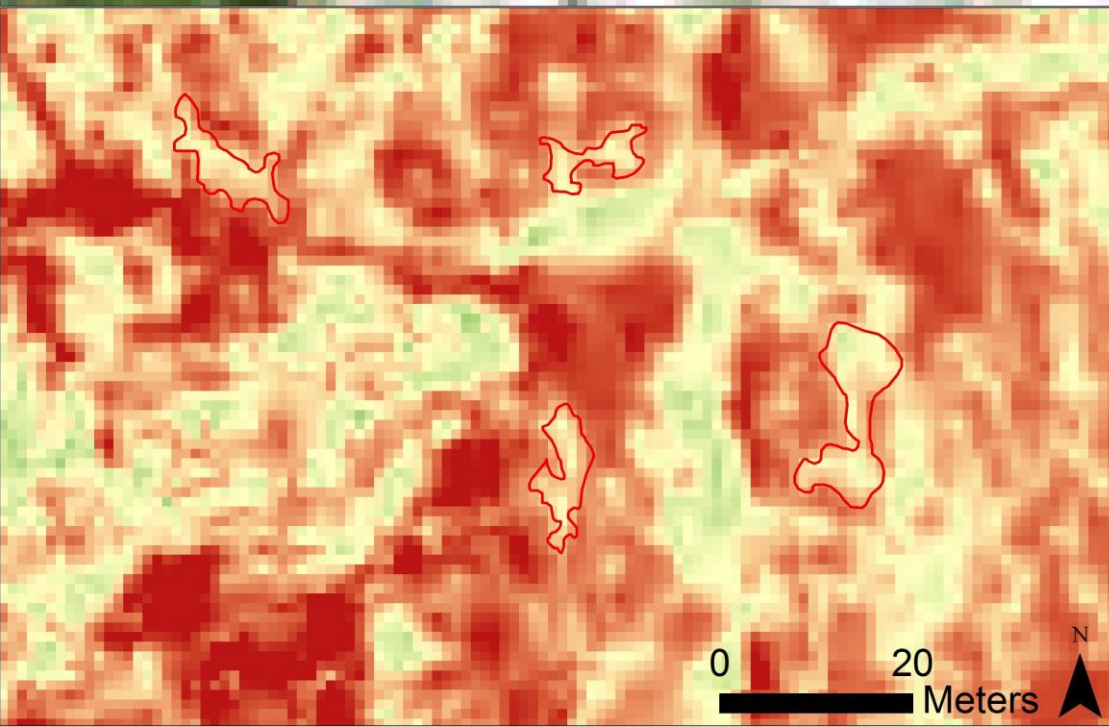
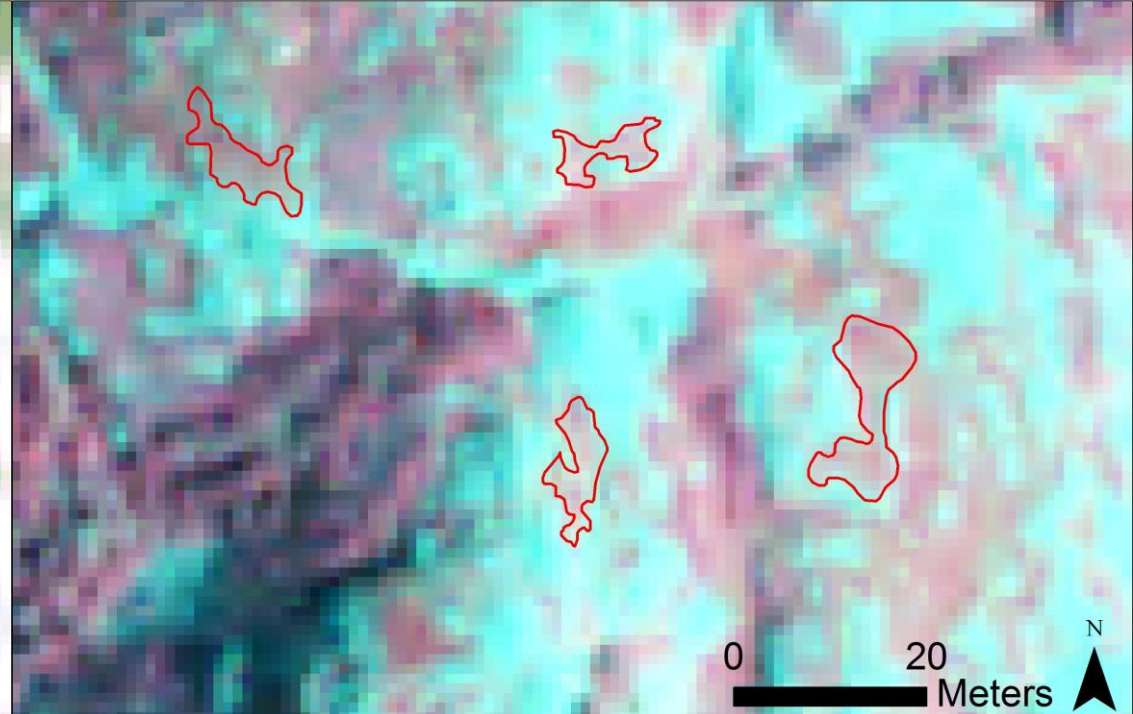
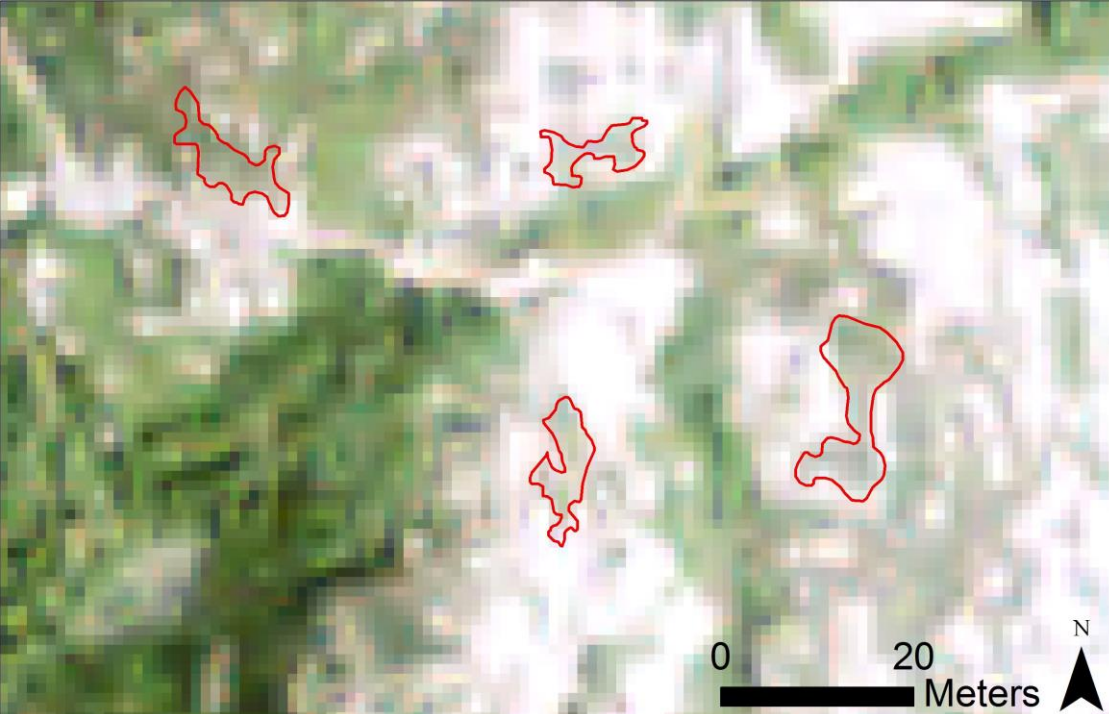


Leaf On – Bare Ground, NAIP 1 meter

NW = True Color

NE = Color Infrared

SW = NDVI

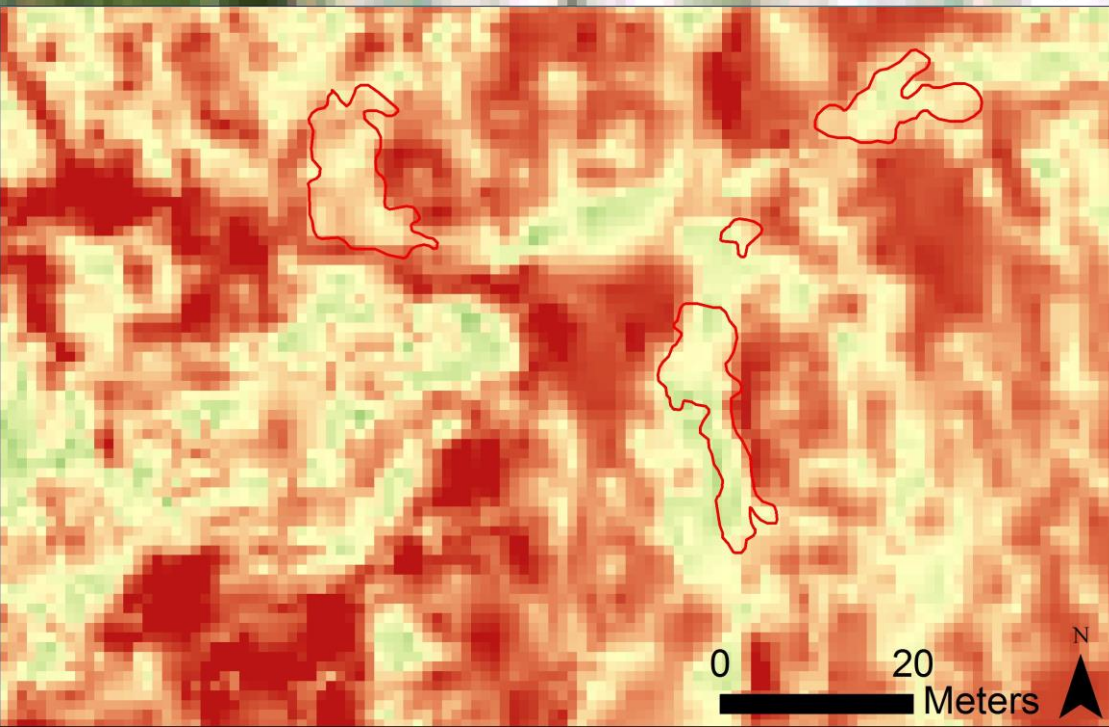
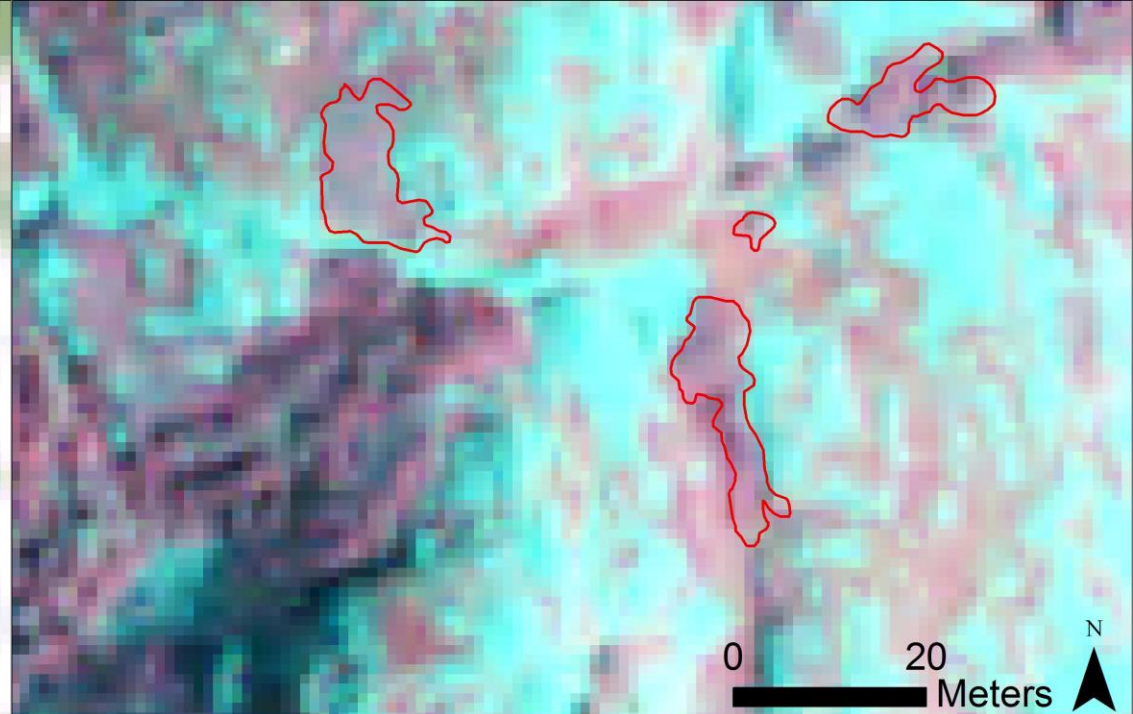
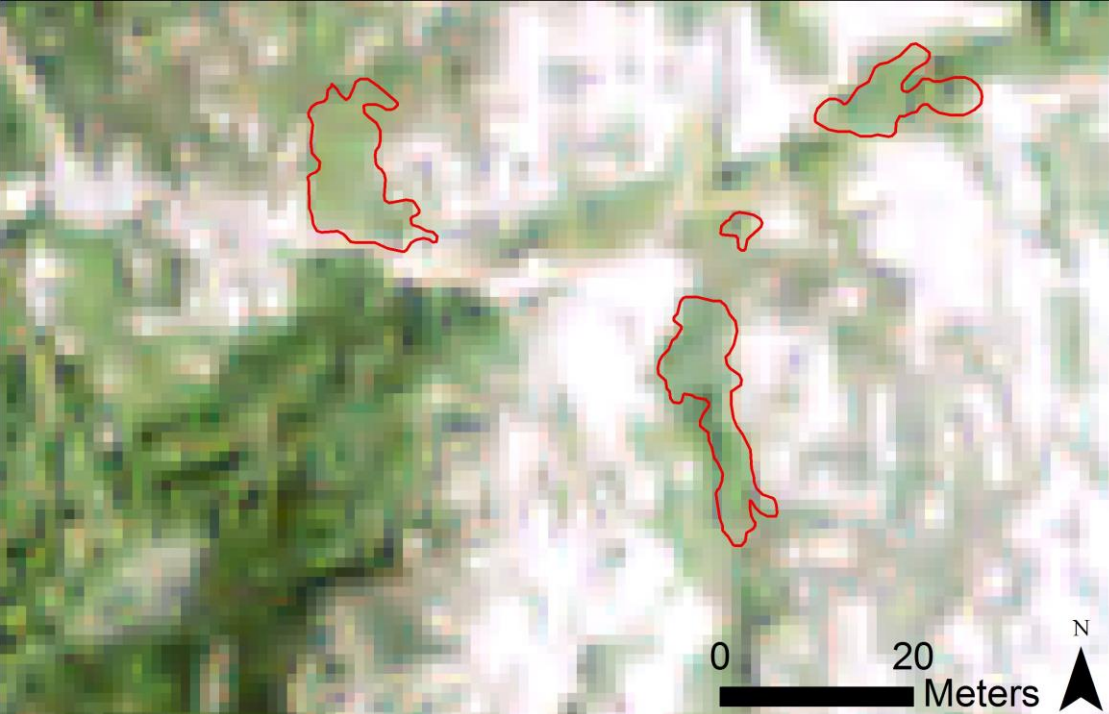


Leaf On – Alpine Vegetation, NAIP 1 meter

NW = True Color

NE = Color Infrared

SW = NDVI



Leaf On – Subalpine Krummholz, NAIP 1 meter

NW = True Color

NE = Color Infrared

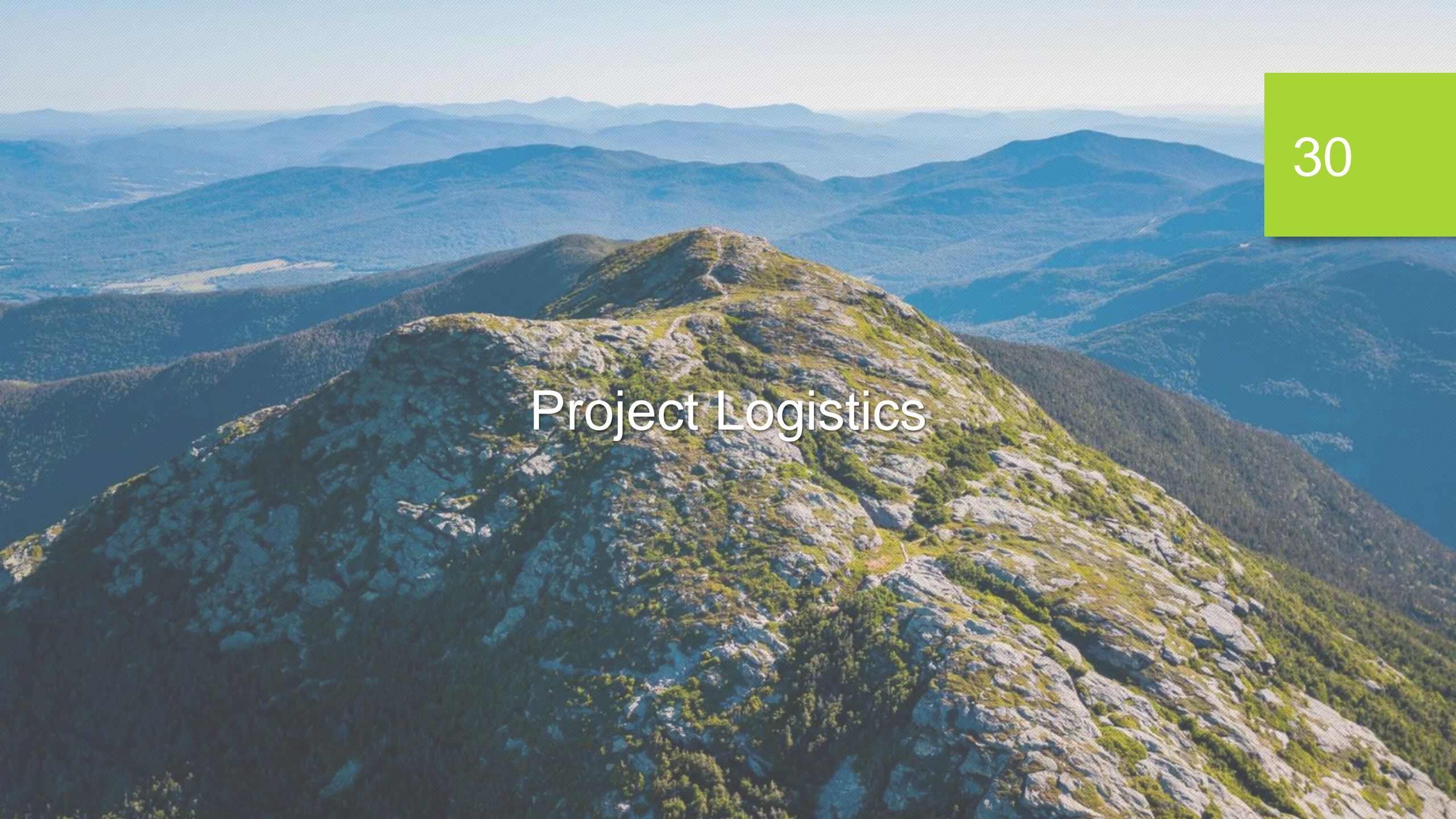
SW = NDVI

Challenges and Limitations

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- Imagery
 - Study area coverage
 - Snow and shadows present
 - Different acquisition dates
- Accuracy Assessment
 - Reference layer
- Assumptions
 - Negligible change to land cover since data collection
 - No attempt to delineate species of alpine vegetation

Project Logistics



Deliverables

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- Shapefiles and Metadata
- eCognition Rule Set
- Land Cover Maps
- Image Interpretation Key
- Comprehensive Report

Project Timeline

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Task	Required Time	Dates
Define and Propose Project	3 Months	August 2018 - October 2018
Acquire Data	1 Month	November 2018
Preprocess Data	2 Months	December 2018 - January 2019
Process Data	3 Months	February 2019 - April 2019
Assess Accuracy	1 Months	May 2019
Create Report	2 Months	June 2019 - July 2019
Submit Paper to Journal	1 Month	August 2019
Submit Abstract to Conference	1 Month	April 2019
Present at Conference	1 Month	October 2019

Presentation Venue(s)

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NORTHEAST ARC USERS GROUP

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NORTHEAST ARC USERS GROUP

The Northeast Arc Users Group (NEARC) is an independent, volunteer organization dedicated to helping users of Esri GIS software be more successful. The geographic area encompassed by the group includes New England and New York. NEARC hosts two conference annually; one in the Spring and one in the Fall. Save these dates!

Spring NEARC Conference
May 14, 2019
Keene State College
Keene, NH

Fall NEARC Conference
October 28-31, 2018
The Saratoga Hilton
Saratoga Springs, NY

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An aerial photograph of a rugged mountain peak. The foreground shows a rocky, light-colored ridge with patches of green vegetation and a narrow dirt trail winding along its crest. The background features a vast, layered mountain range under a clear blue sky, with deep valleys and forested slopes. The overall scene is bright and expansive.

End