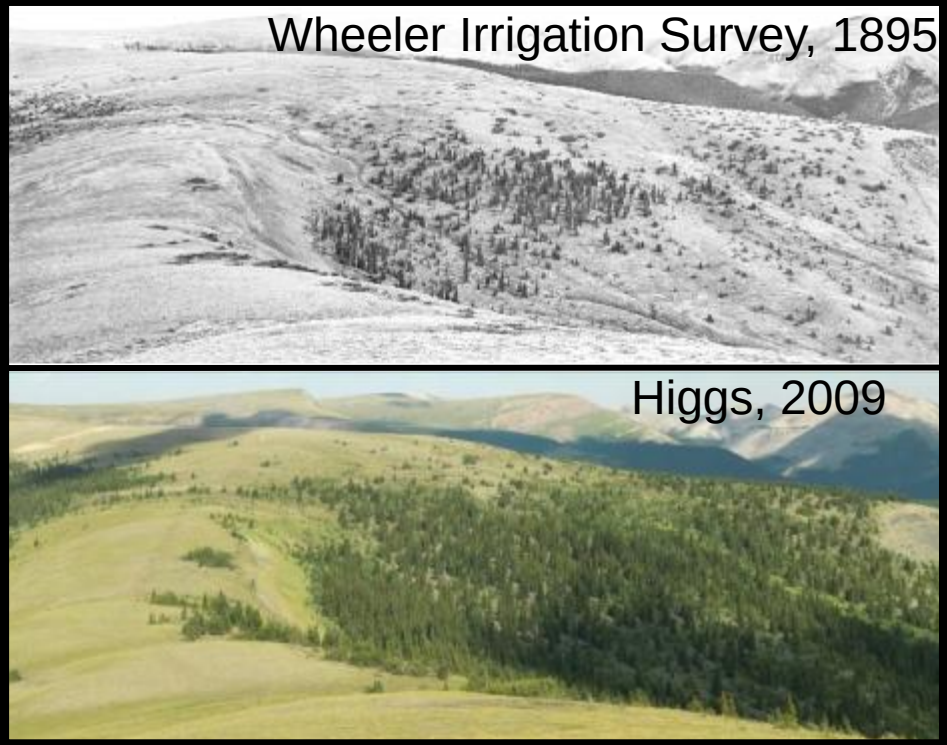
Georeferencing oblique landscape photos to evaluate century-scale changes in the structure of Rocky Mountain and foothills landscapes



Chris Stockdale - PhD Candidate

Committee
Ellen Macdonald - supervisor
Mike Flannigan
Eric Higgs

WESTERN PARTNERSHIP FOR WILDLAND FIRE SCIENCE

UNIVERSITY OF ALBERTA

Mountain Legacy
The Canadian Rockies 1861 to the Present

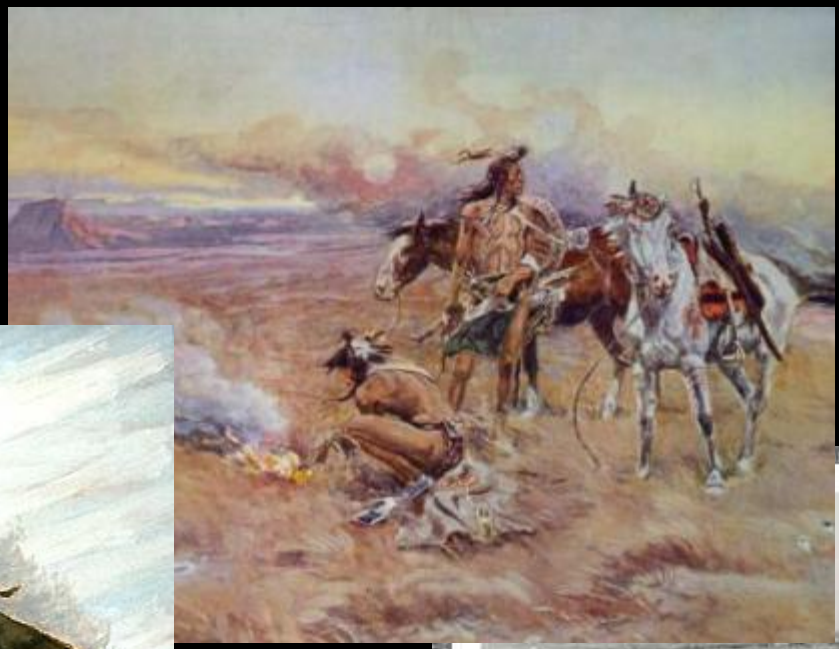
WSL Swiss Federal Institute for Forest, Snow and Landscape Research WSL

Natural Sciences and Engineering Research Council of Canada
www.nserc-crsng.gc.ca

Alberta Innovates Technology Futures

April 25, 2014
Banff AB
Mountain Cartography Workshop

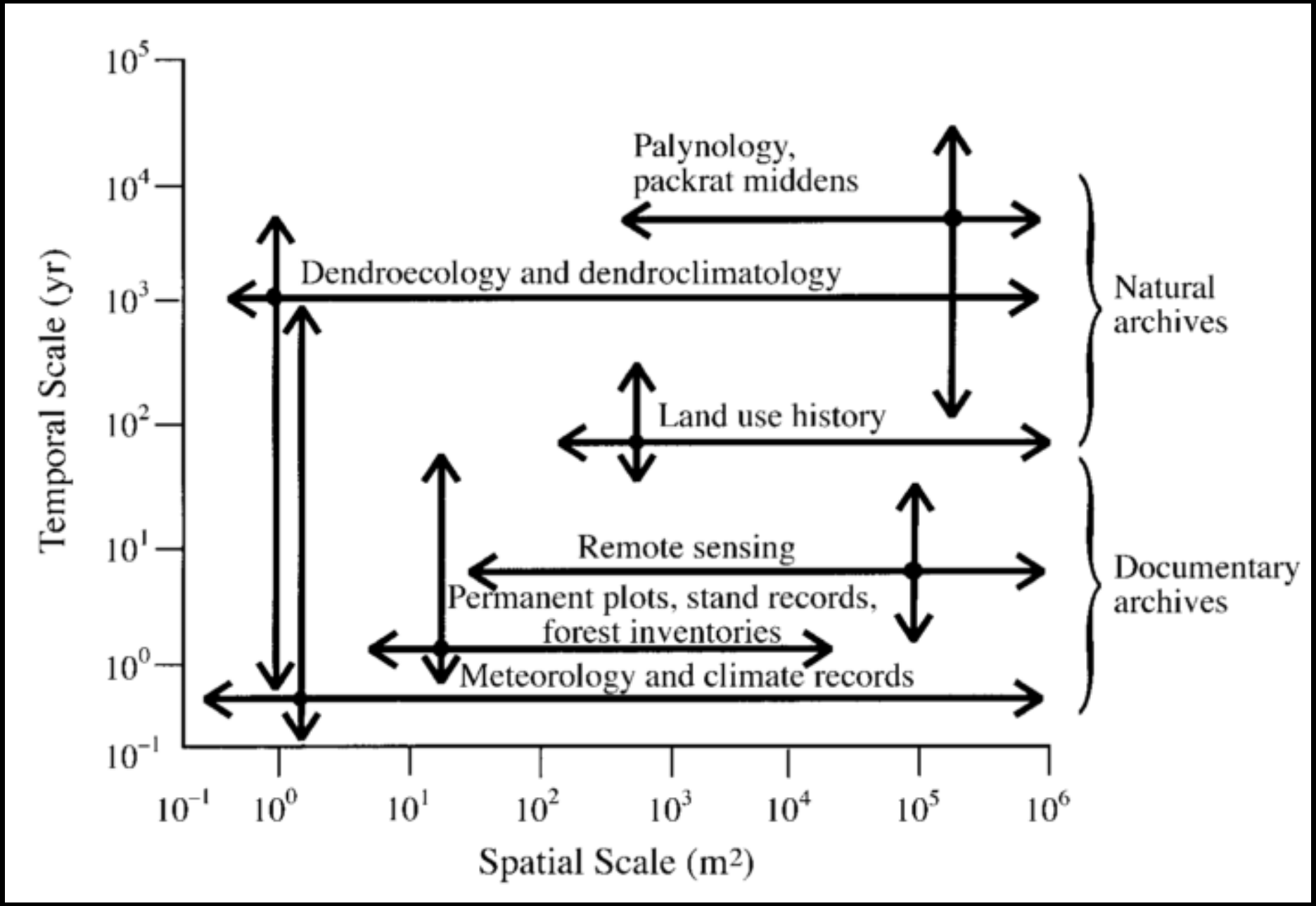
History



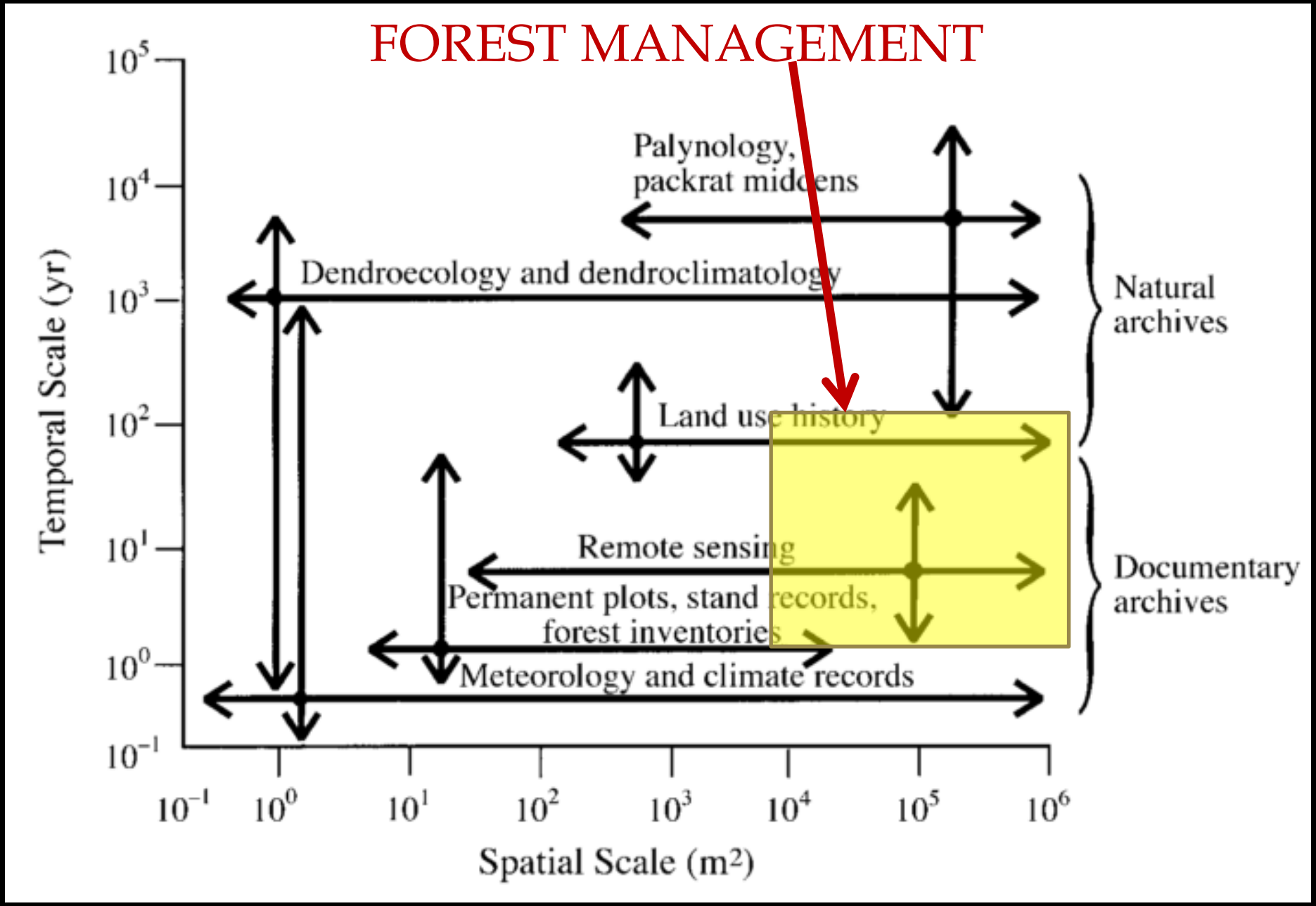
History
Why does it matter?

Planning for the future without knowledge of the past is inherently riskier than the alternative.

"We are more likely to use the present to attempt to reconstruct the past, than we are to use the past to understand the present and guide the future."
- Stephen Pyne



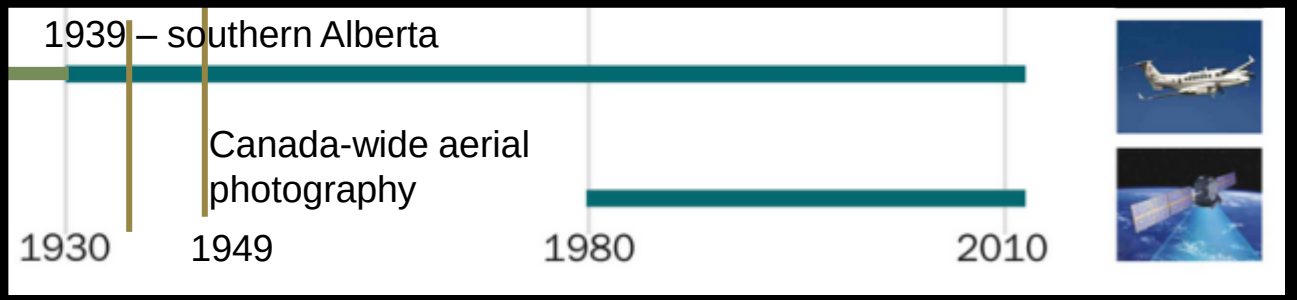
From: Swetnam *et al.* 1999. Applied Historical Ecology: Using the past to manage for the future

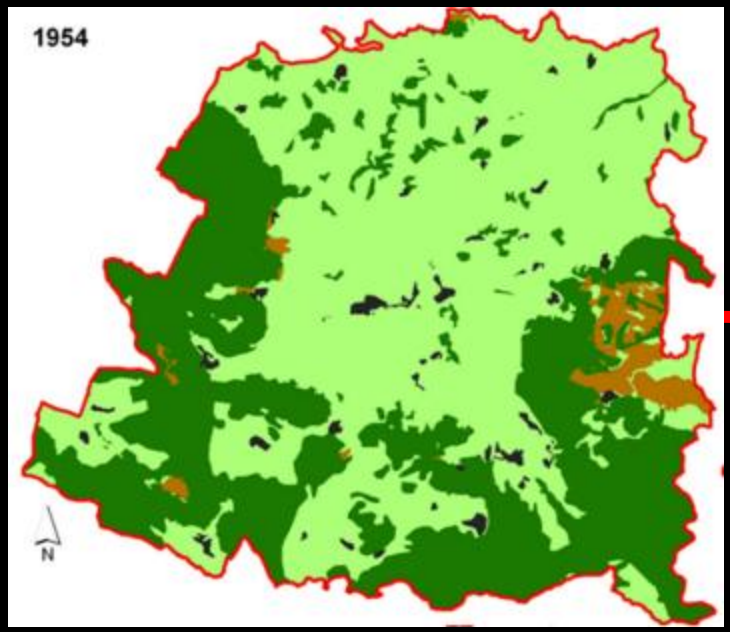


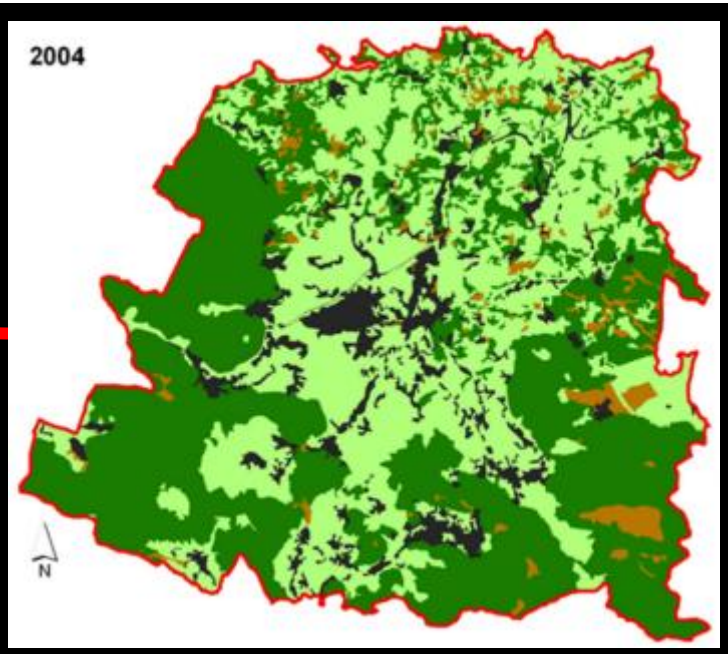
From: Swetnam *et al.* 1999. Applied Historical Ecology: Using the past to manage for the future

Remote Sensing

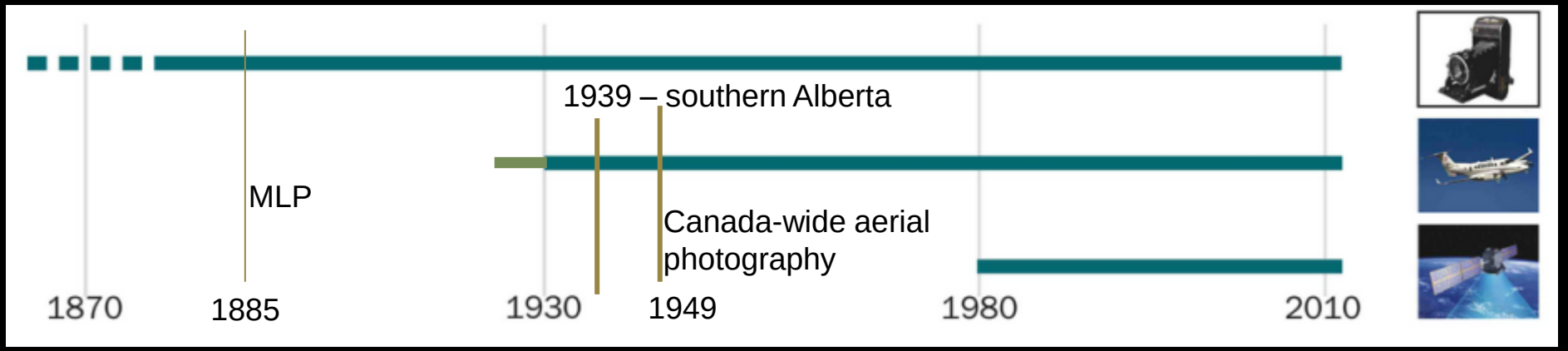
A more complete view

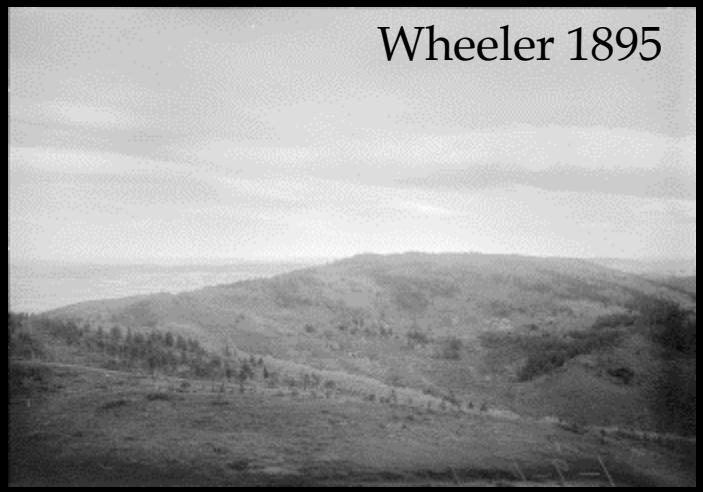






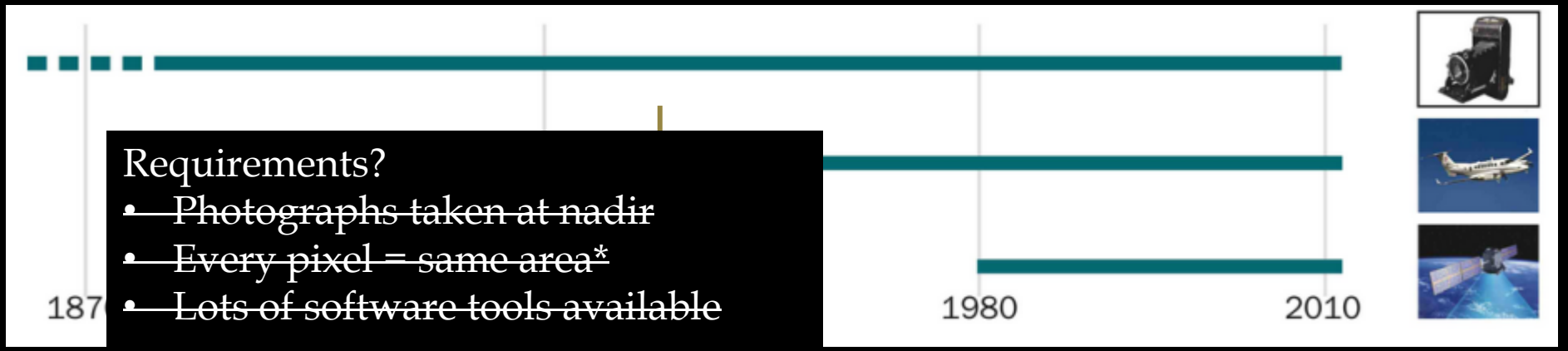
Remote Sensing



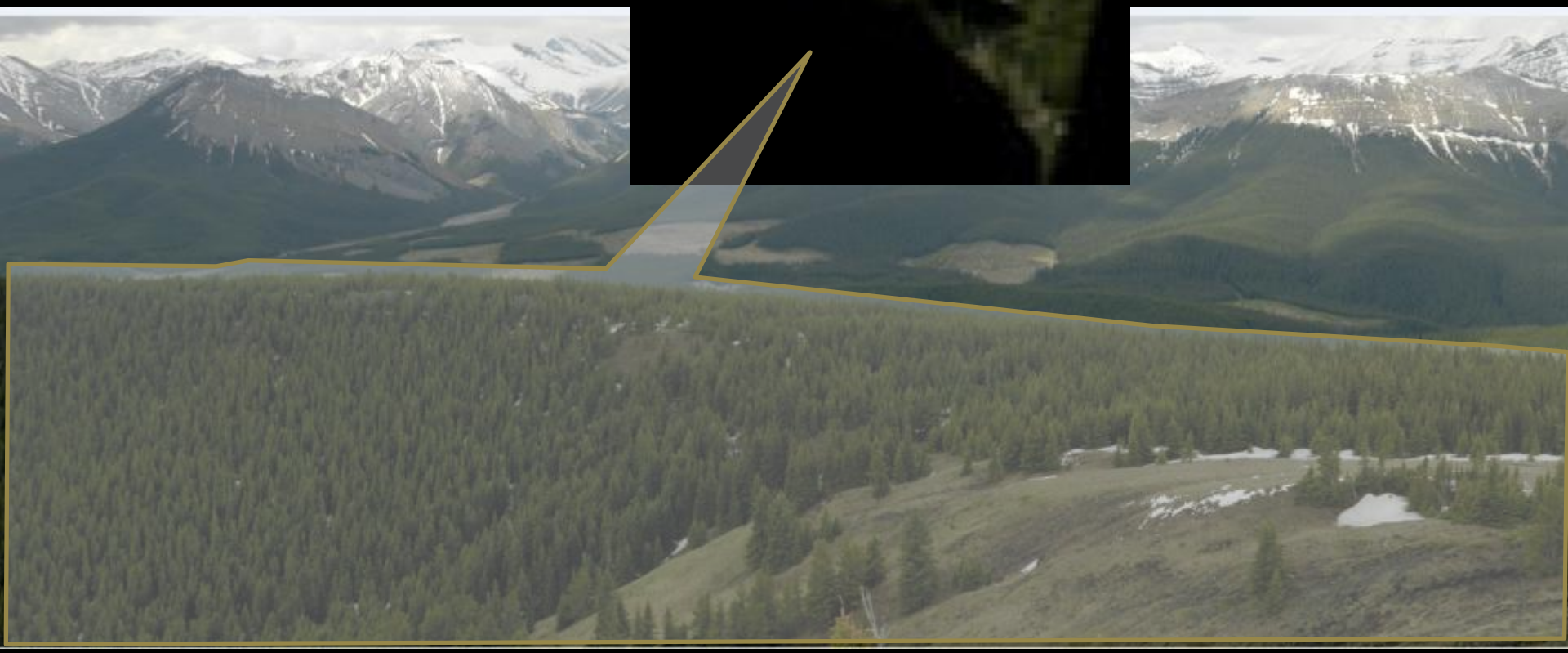


Remote Sensing

A more complete view

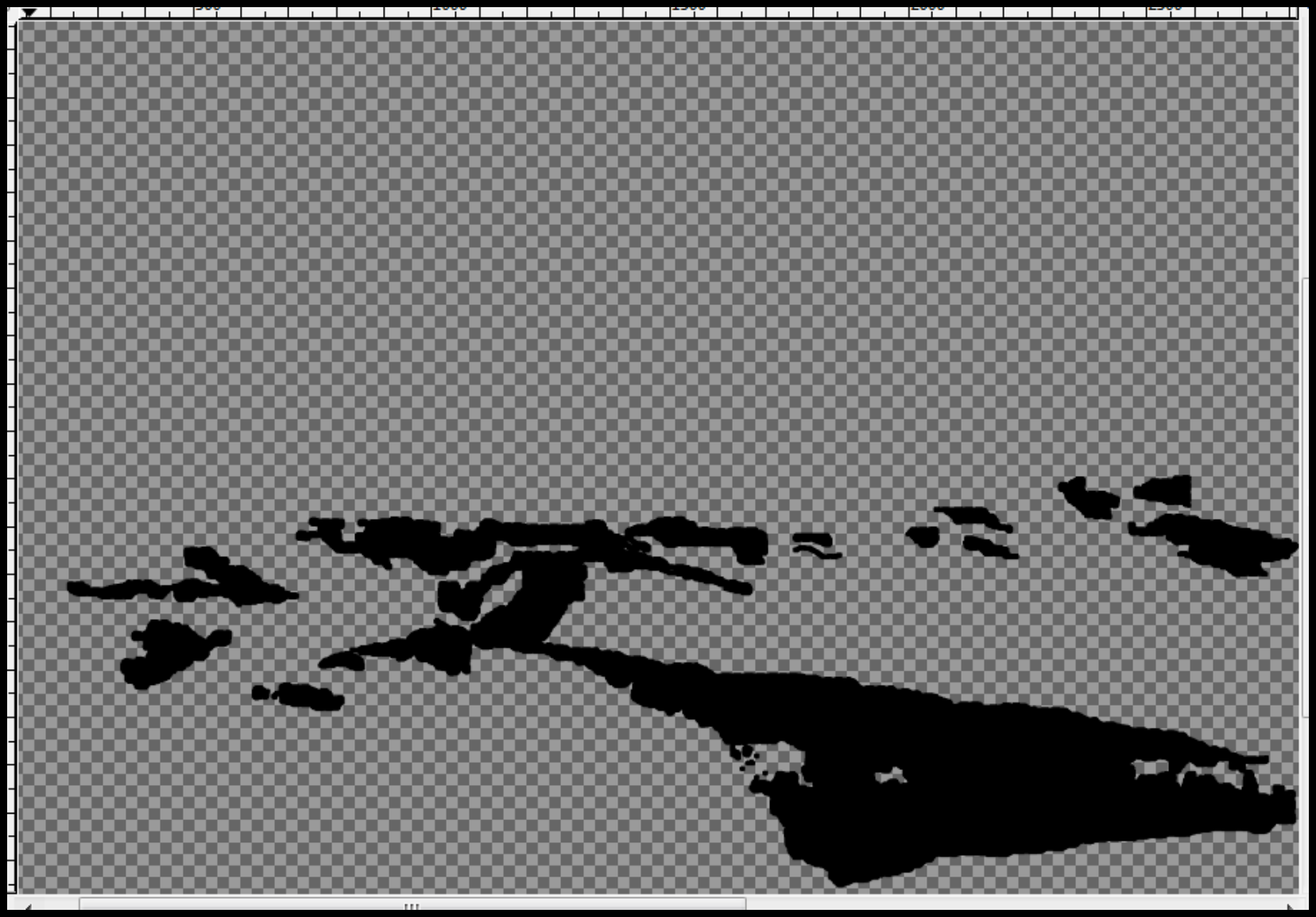


Rubbersheeting

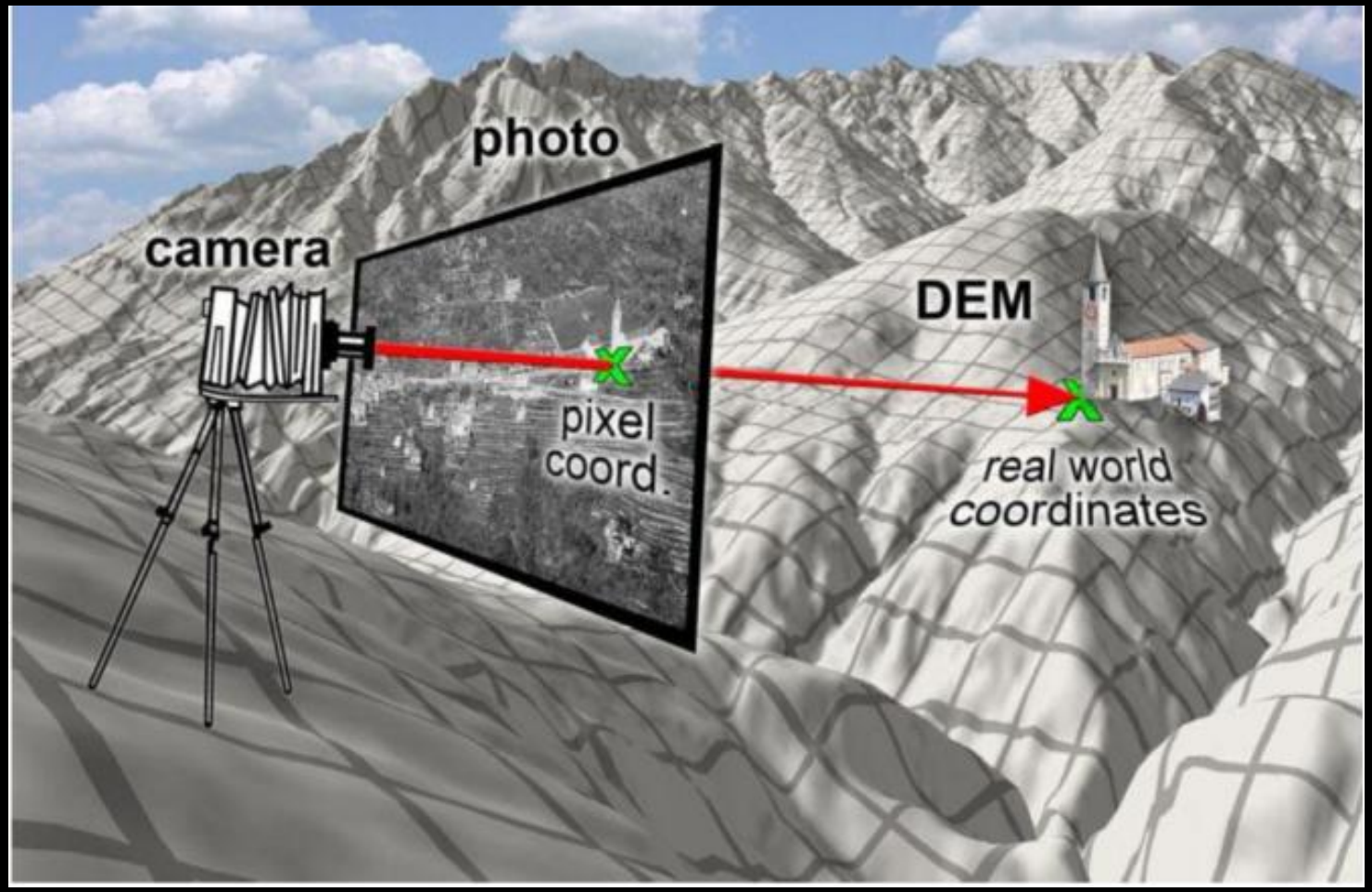


Can’t interpret vegetation after georeferencing

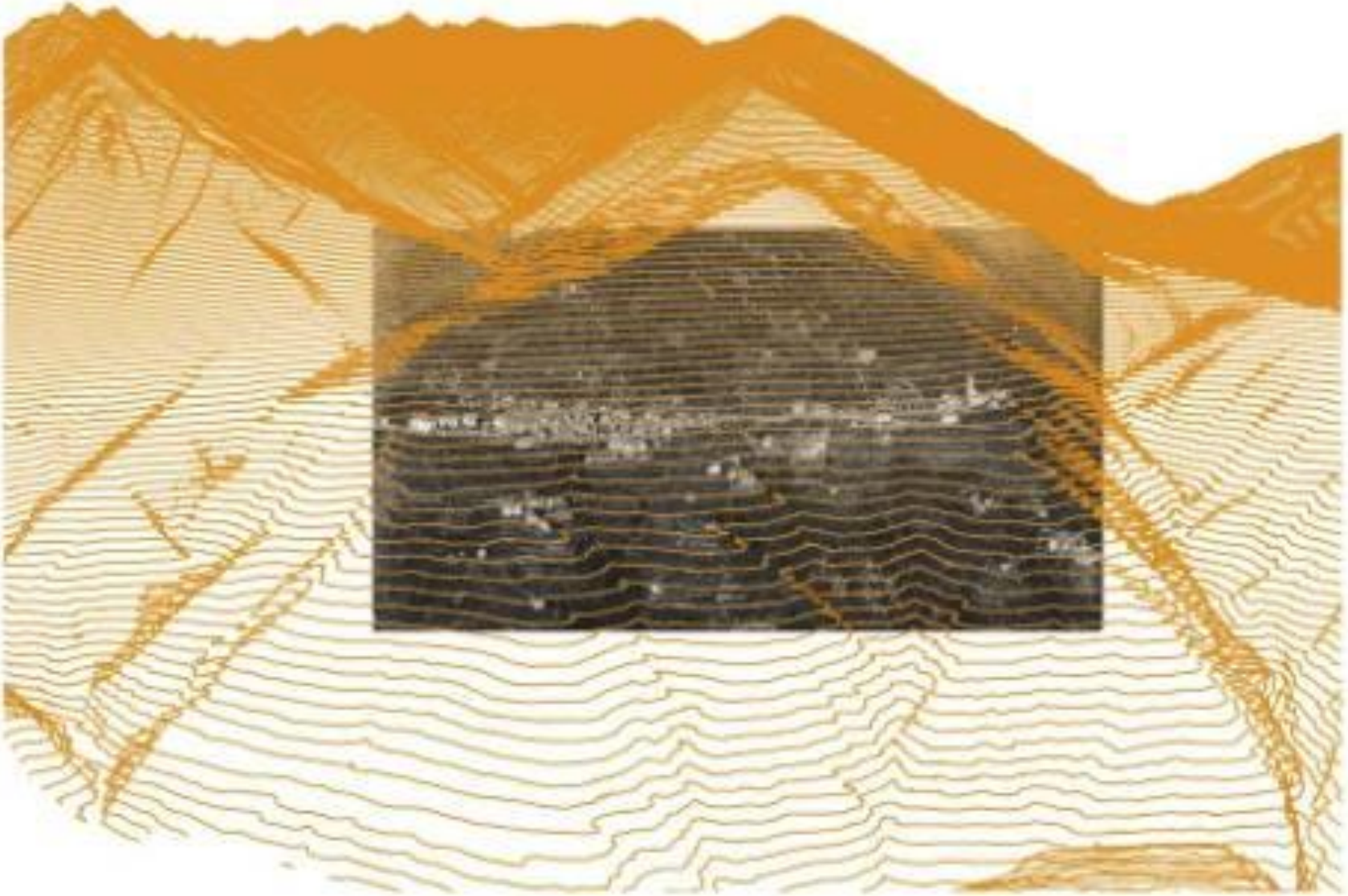
Bridgland, 1913

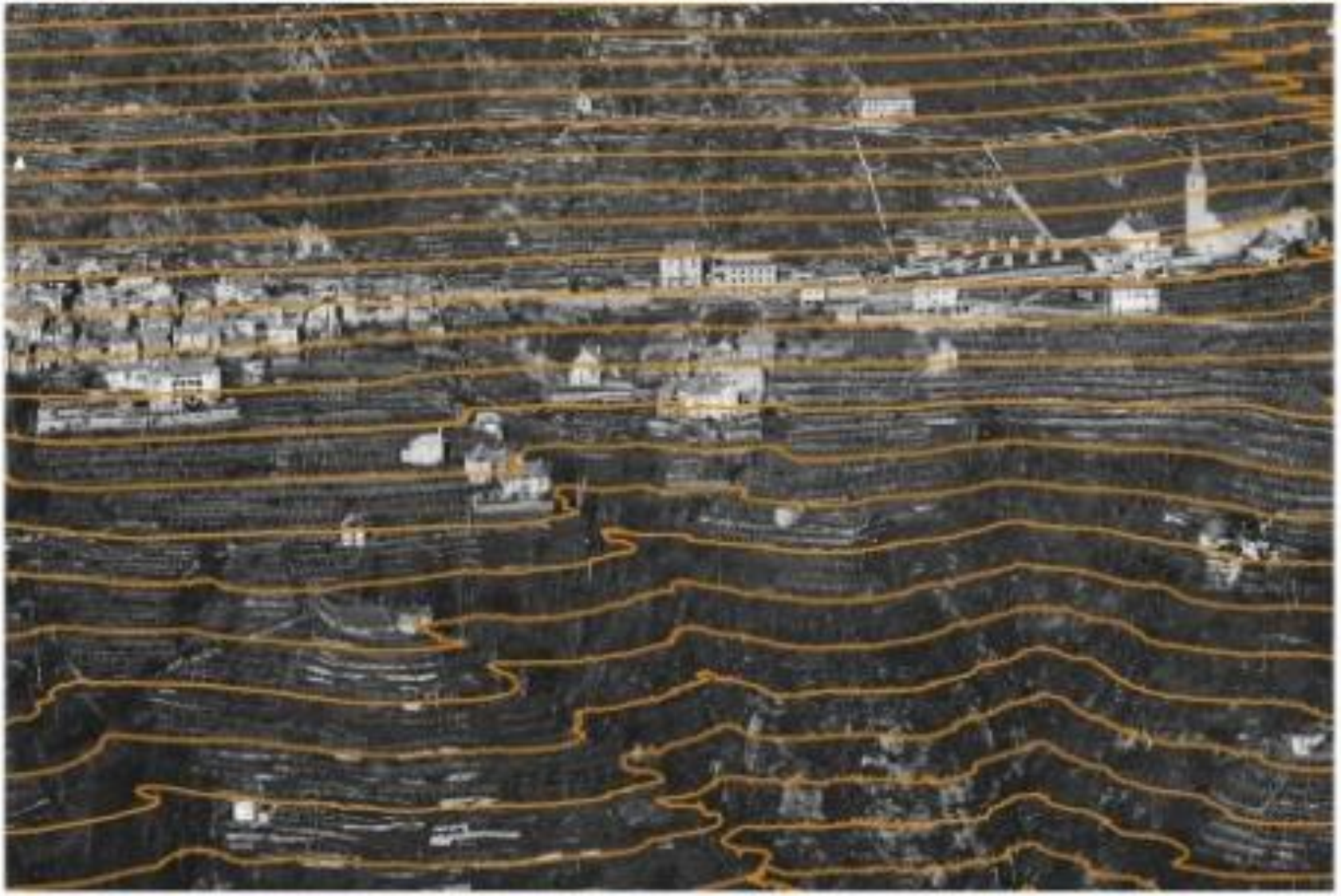


Digital Monoplotting for Georeferencing Oblique Photography



From: C. Bozzini, M. Conedera, P. Krebs 2012. A New Monoplotting Tool to Extract Georeferenced Vector Data and Orthorectified Raster Data from Oblique Non-Metric Photographs. *International Journal of Heritage in the Digital Era*





original document

a cropping of the original document with the shared frame in which vegetation categories were plotted and traced out

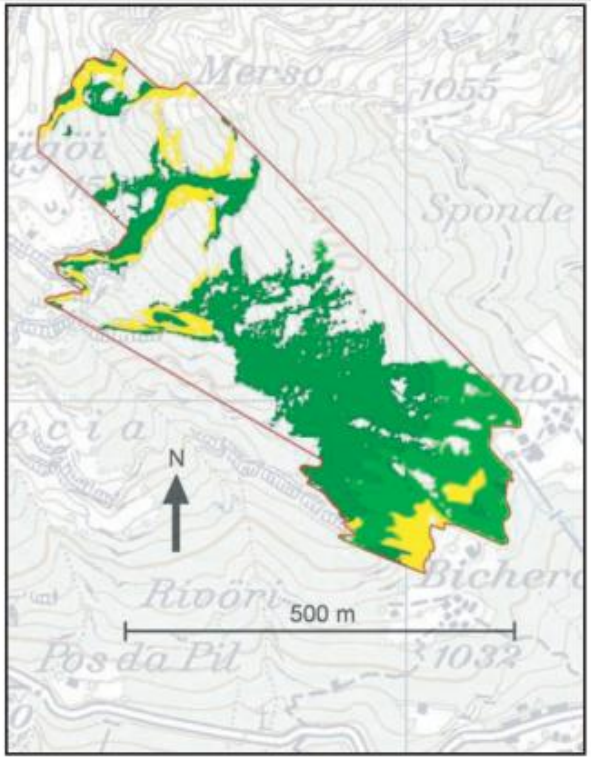
orthogonal view

vegetation categories placed upon a current topographic map and intersected with the shared viewshed

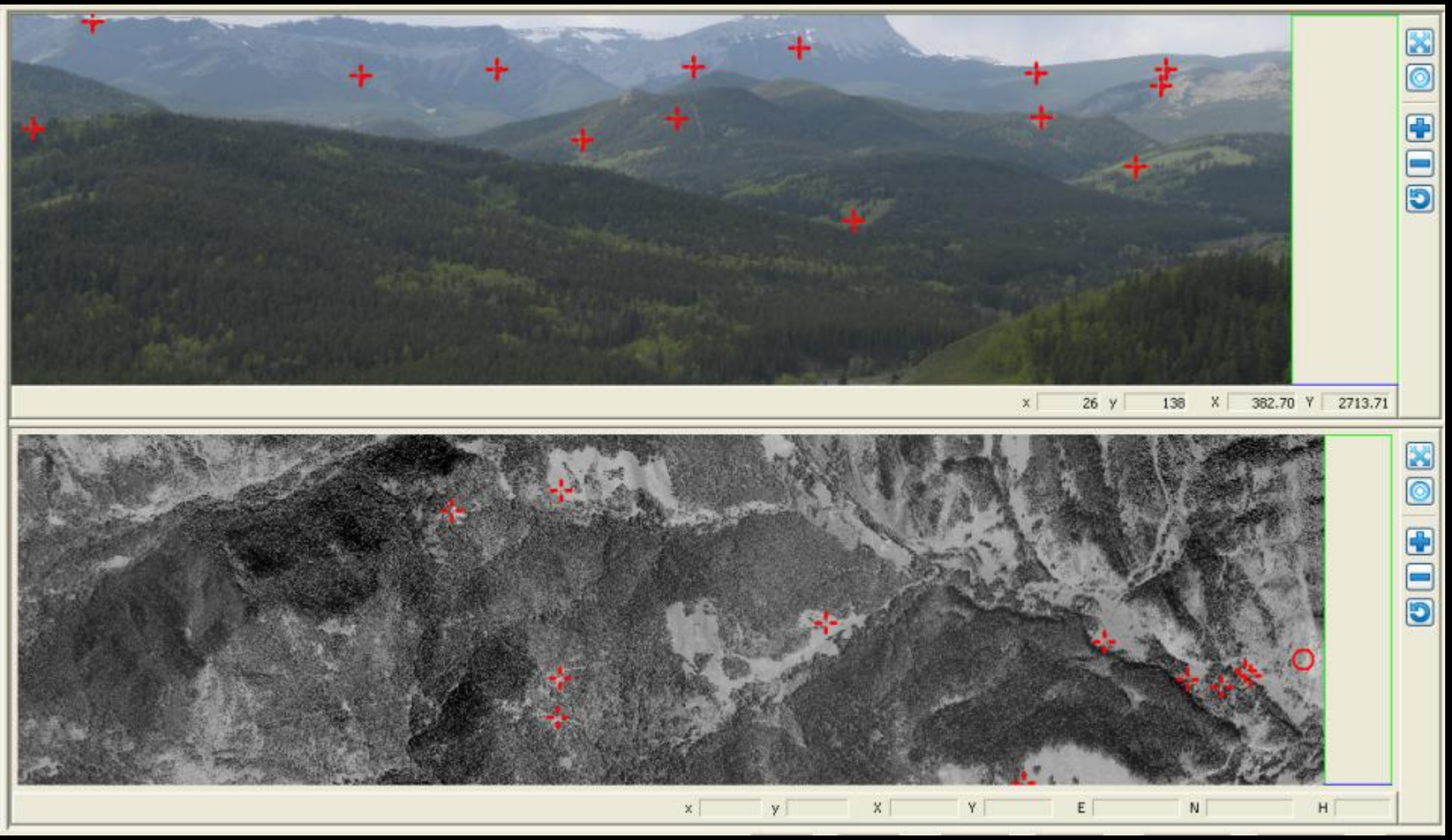
old photo perspective

vegetation categories inside the shared frame projected into the perspective of the 1933 photo

new photo (2012)



number of plotted features: 16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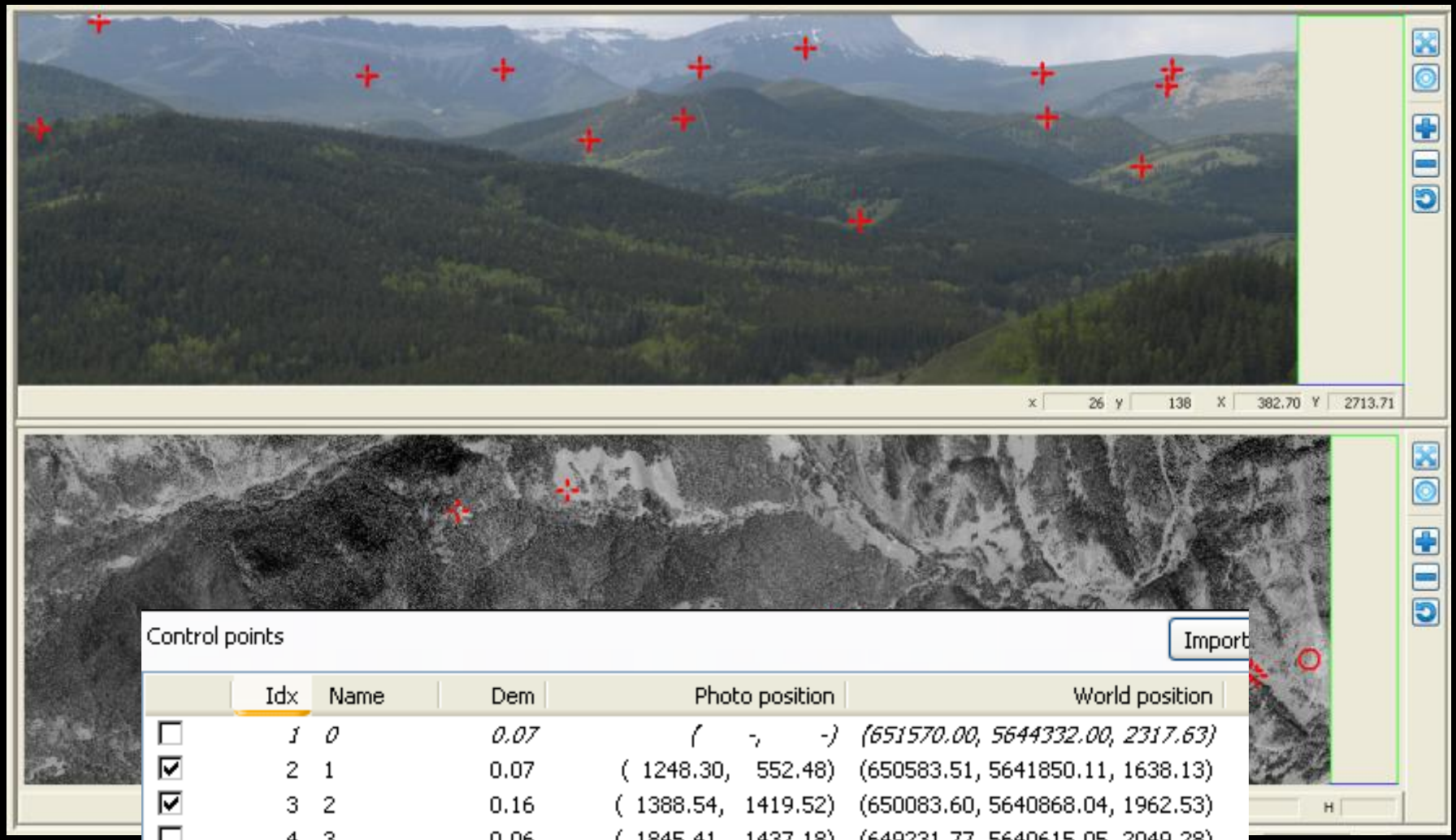
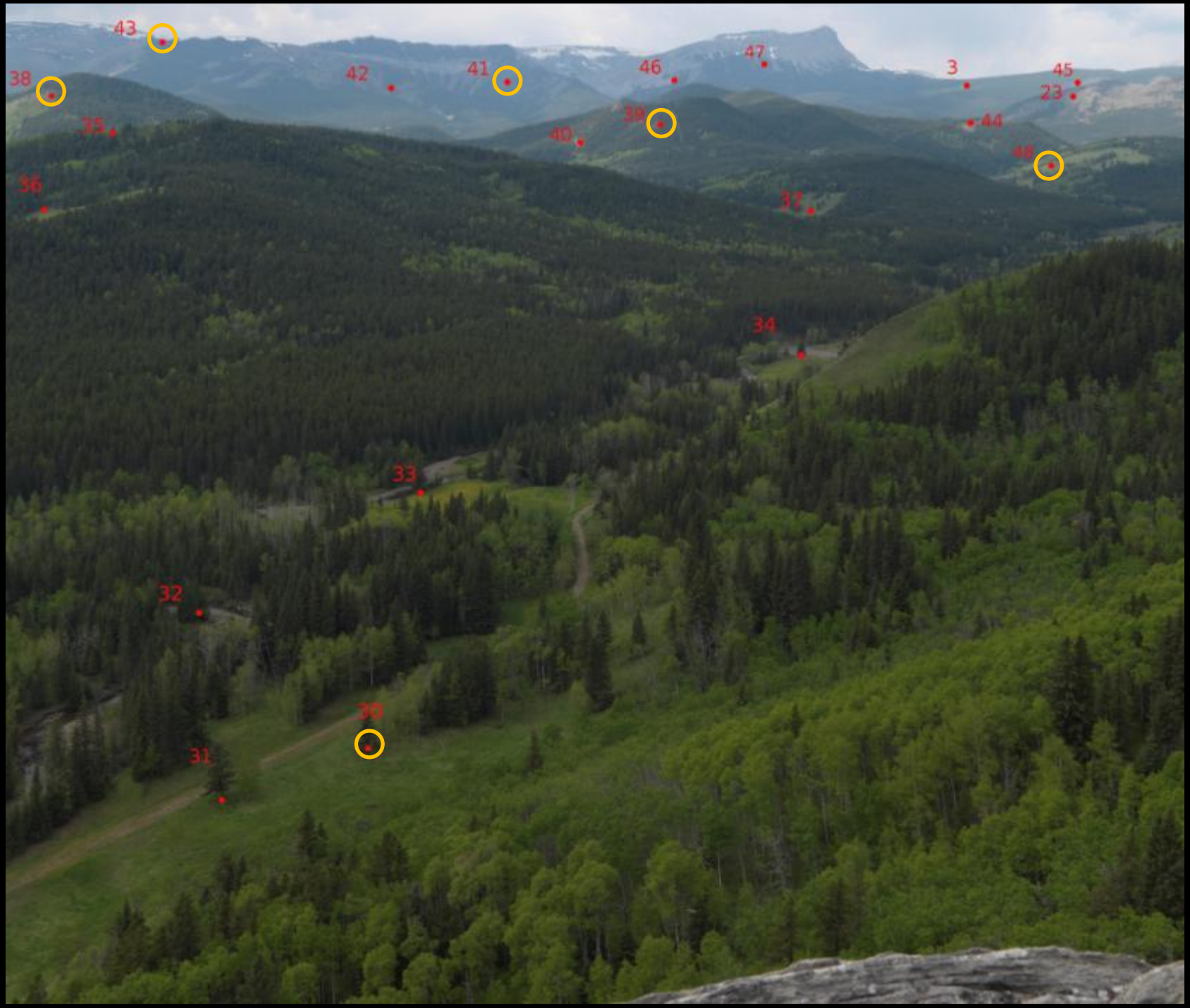
x y X Y E N H



Control points

Import

	Idx	Name	Dem	Photo position	World position
☐	*1*	*0*	*0.07*	*(-, -)*	*(651570.00, 5644332.00, 2317.63)*
☑	2	1	0.07	(1248.30, 552.48)	(650583.51, 5641850.11, 1638.13)
☑	3	2	0.16	(1388.54, 1419.52)	(650083.60, 5640868.04, 1962.53)
☐	4	3	0.06	(1845.41, 1437.18)	(649231.77, 5640615.05, 2049.28)
☑	5	4	0.05	(2533.47, 776.45)	(649872.35, 5641937.47, 1656.13)
☑	6	5	0.22	(3768.46, 865.64)	(650207.40, 5643131.22, 1938.41)
☑	7	6	0.06	(4200.36, 1415.39)	(646848.32, 5640848.13, 1748.46)
☑	8	7	0.24	(4399.37, 1704.12)	(645626.07, 5640272.66, 2025.80)
☐	9	8	0.17	(4494.49, 1093.31)	(648966.26, 5642632.43, 1827.57)
☑	10	9	0.02	(5574.62, 1496.13)	(644641.60, 5641366.31, 1765.78)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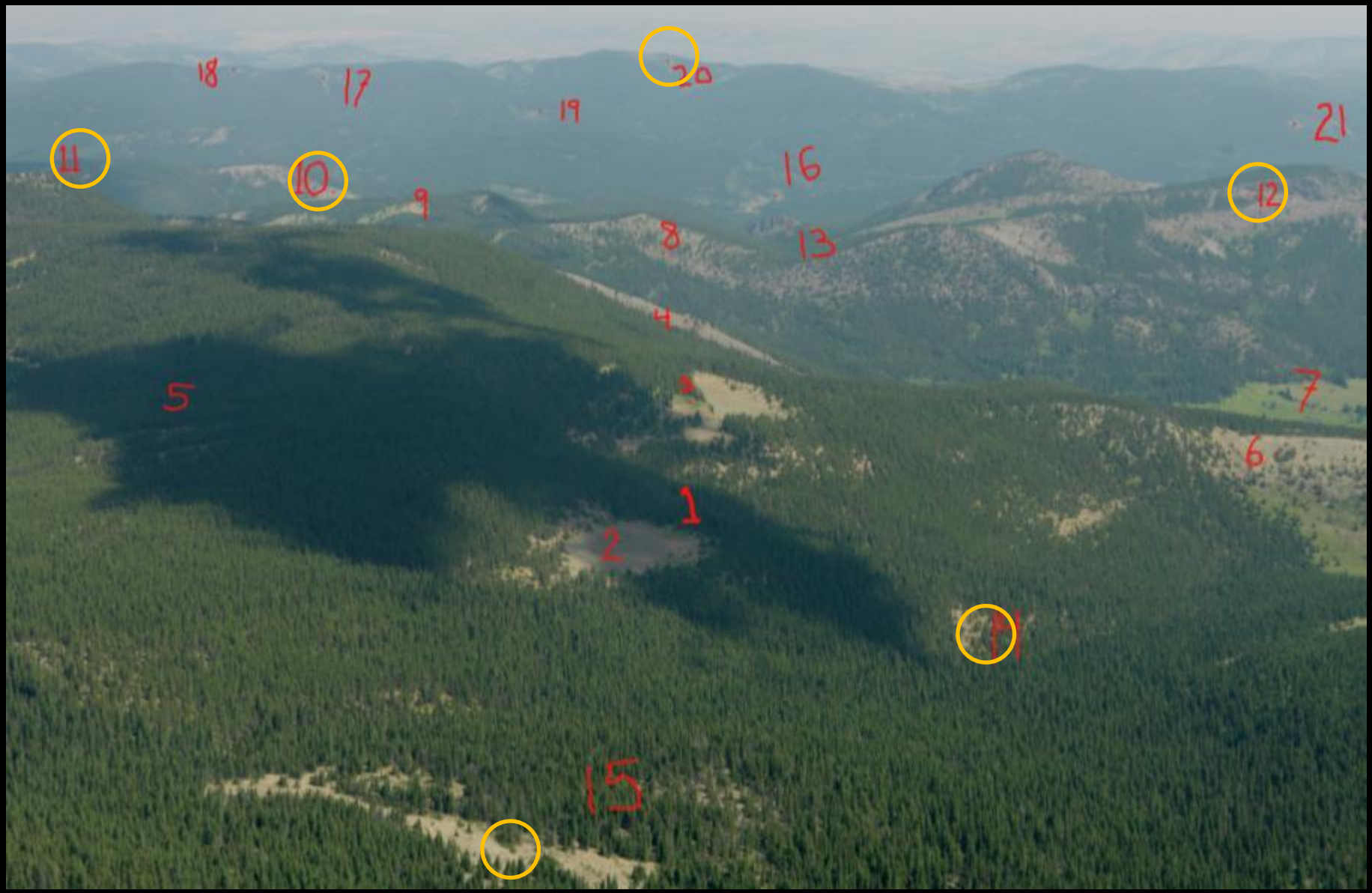
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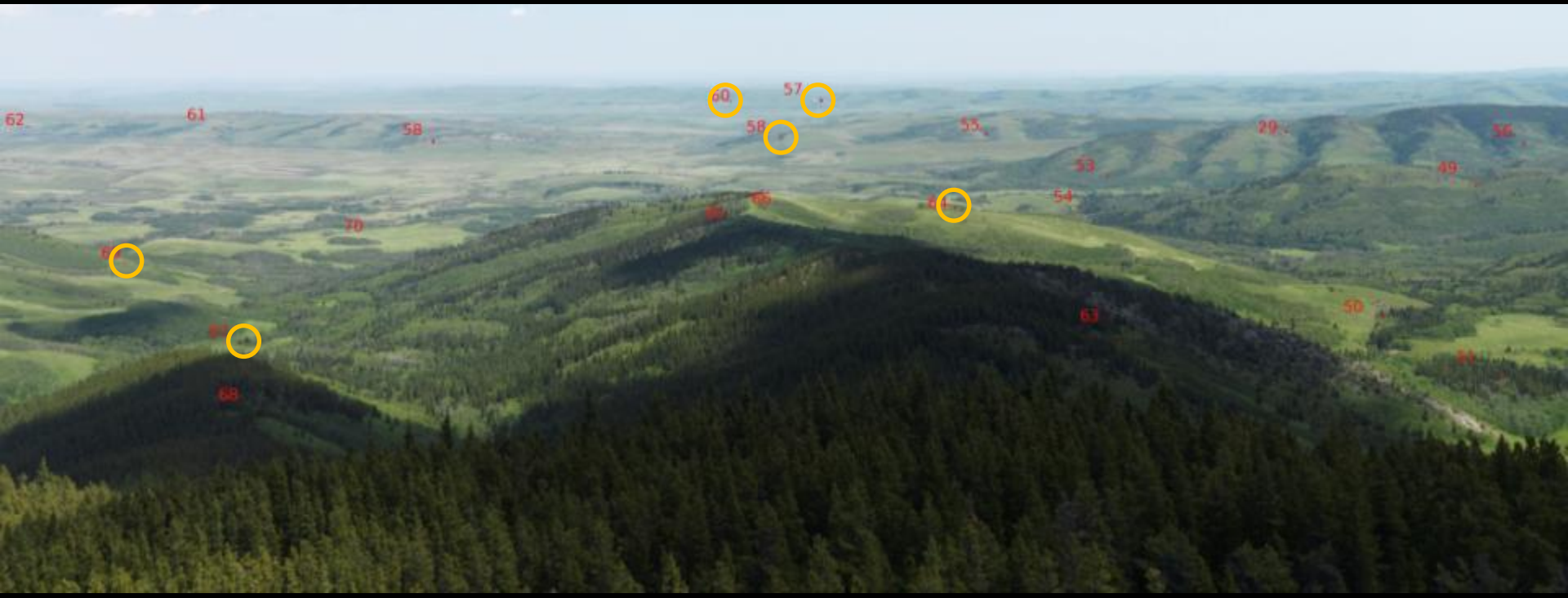
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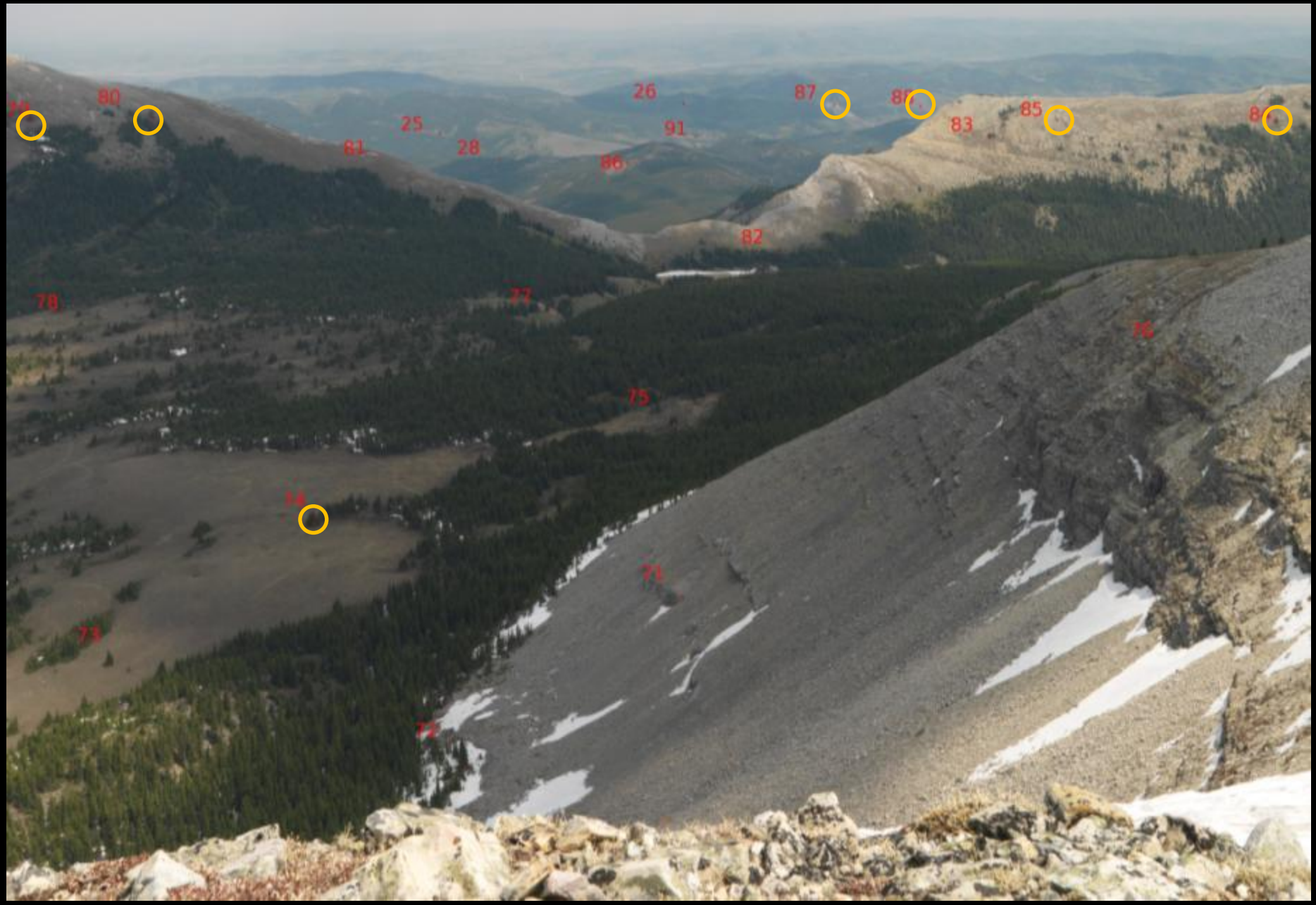
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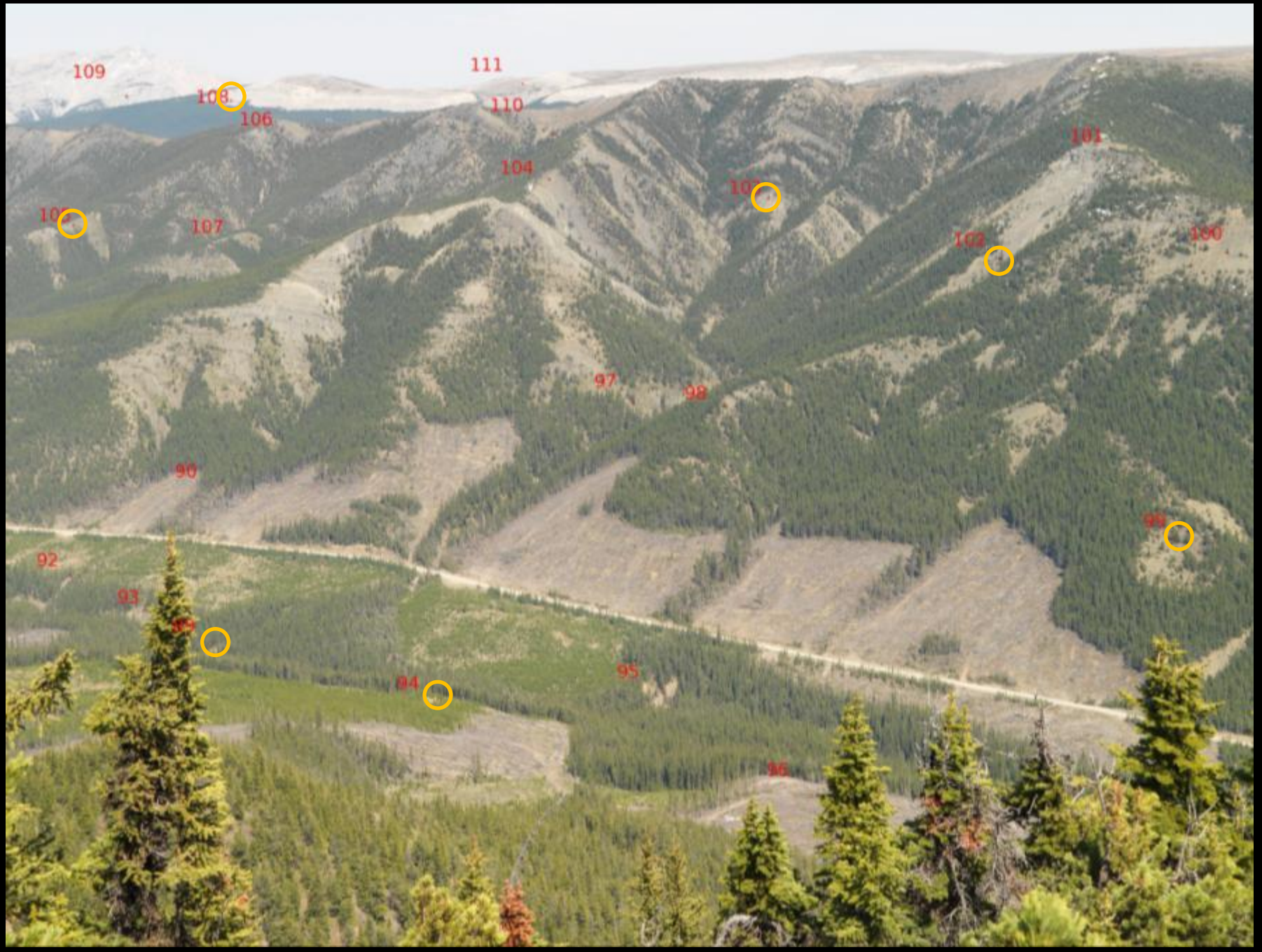
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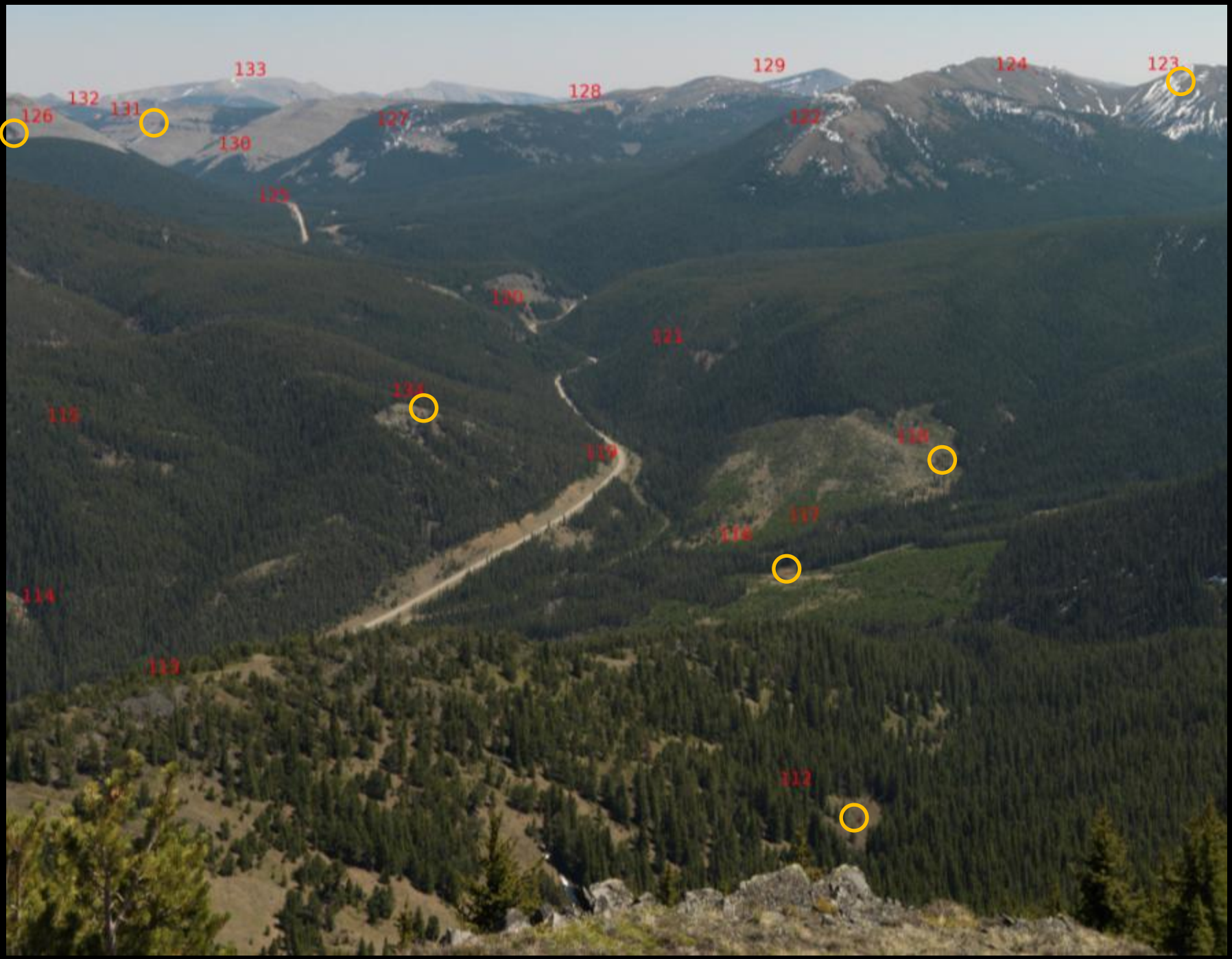
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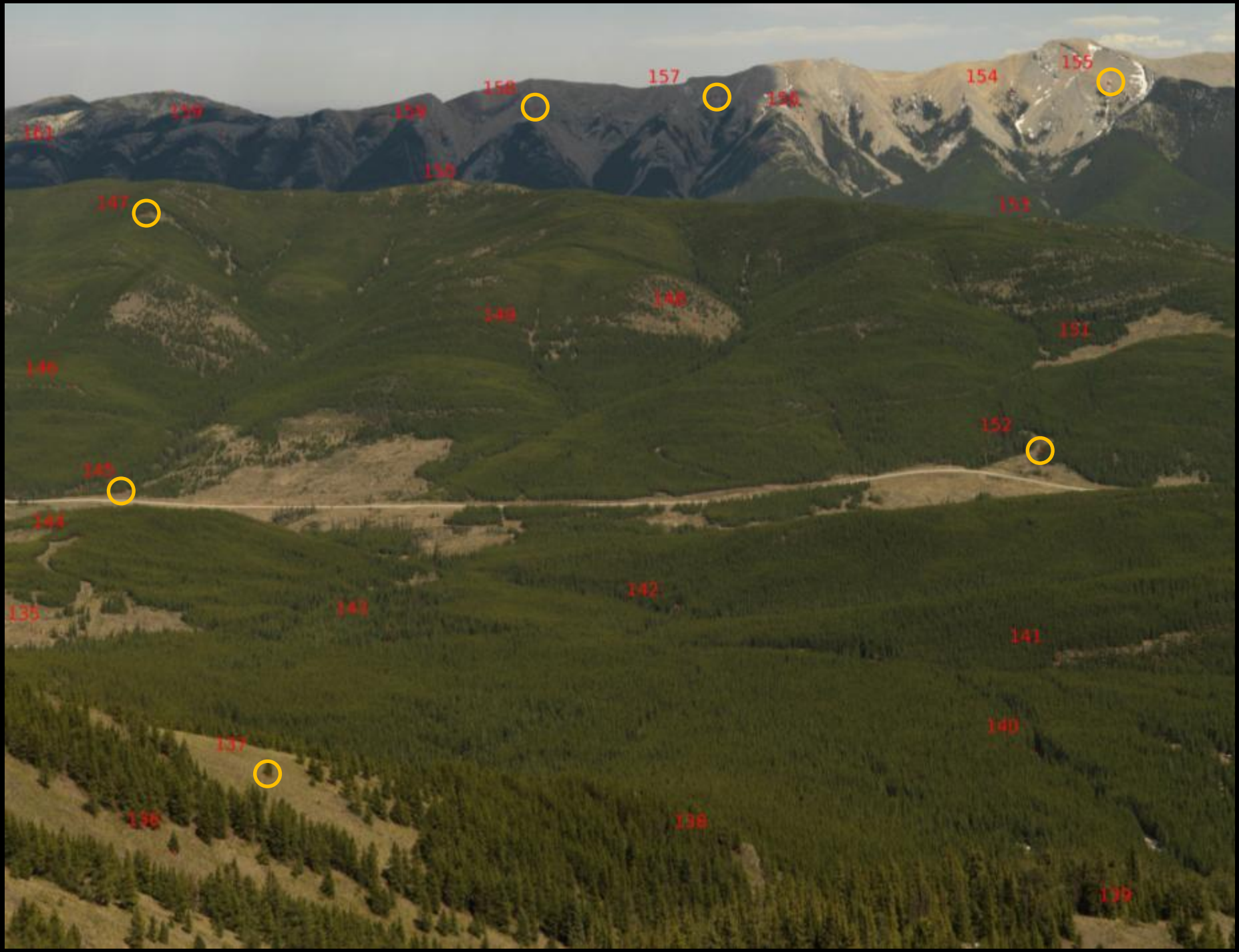
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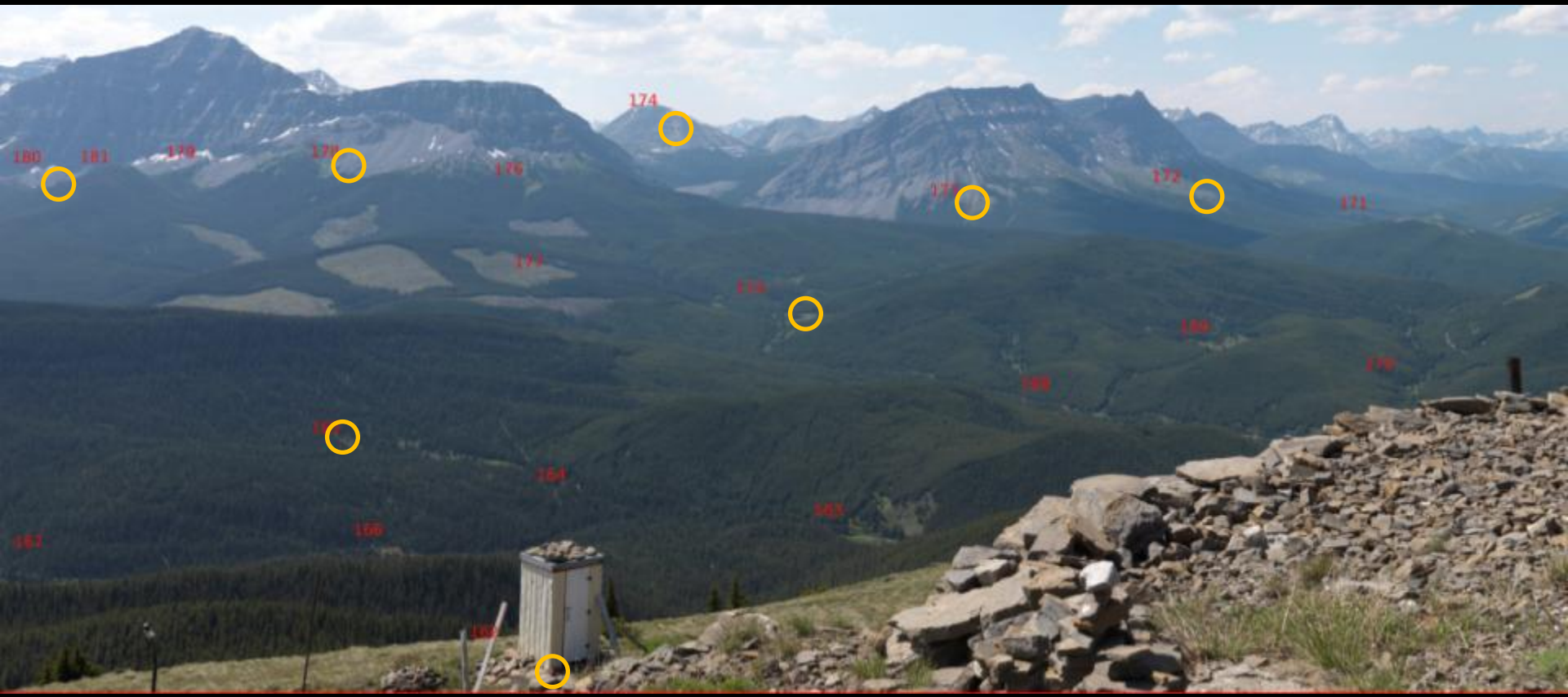
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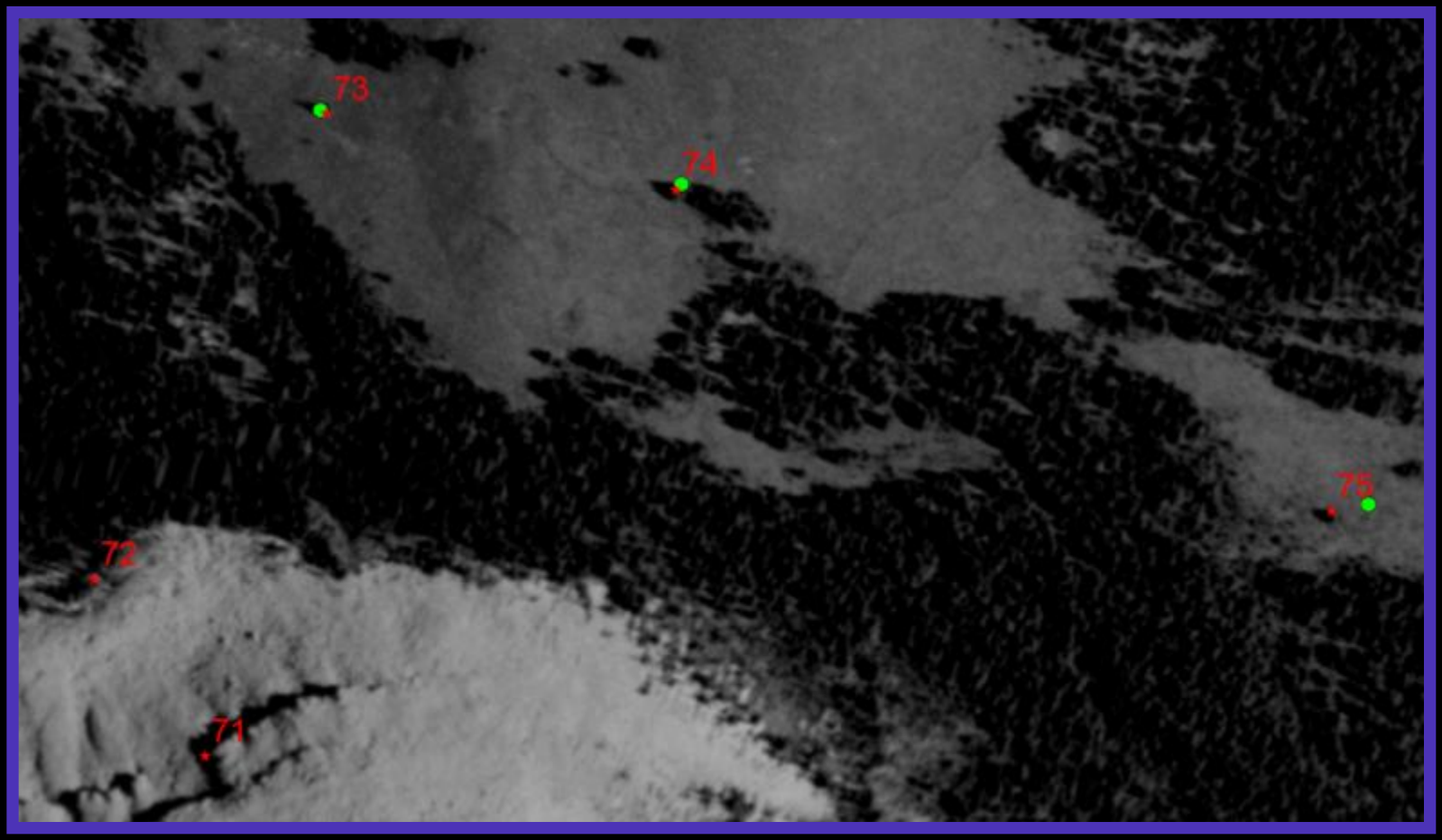
ACCURACY TEST

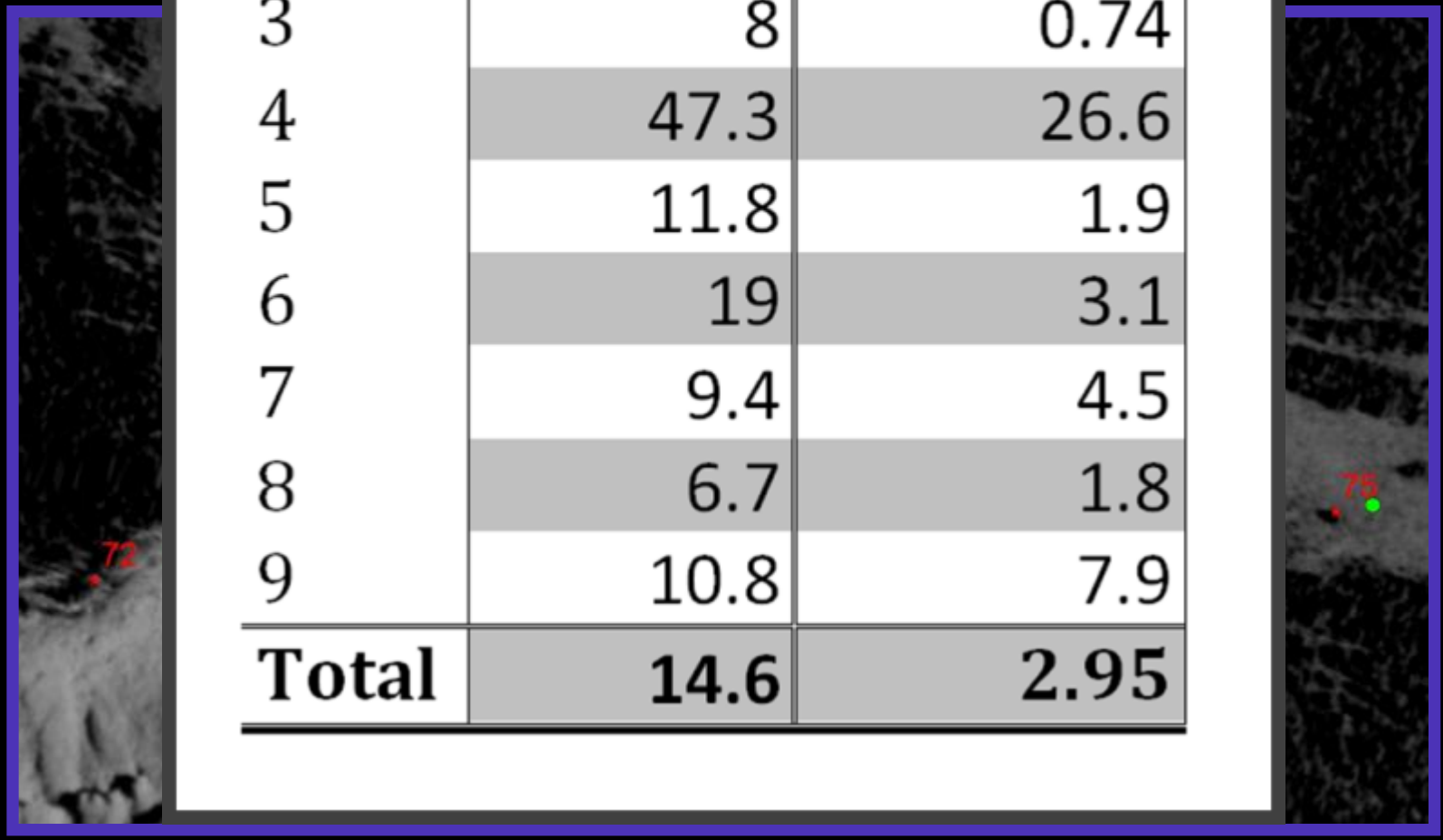
1. 8 images used
2. 21 control points established in each image
3. 6 Anchor Points used to georeference the image
4. Remaining 15 control points (TEST points) are georeferenced in Monoplotting tool
5. Locations compared to Control Point



ACCURACY TEST

1. 8 images
2. 21 contro
3. 6 Anchor
4. Remainir
   in Monoj
5. Location

Image	Vector Error (m)	Displacement Error (m)
1	3.9	1.7
3	8	0.74
4	47.3	26.6
5	11.8	1.9
6	19	3.1
7	9.4	4.5
8	6.7	1.8
9	10.8	7.9
Total	**14.6**	**2.95**

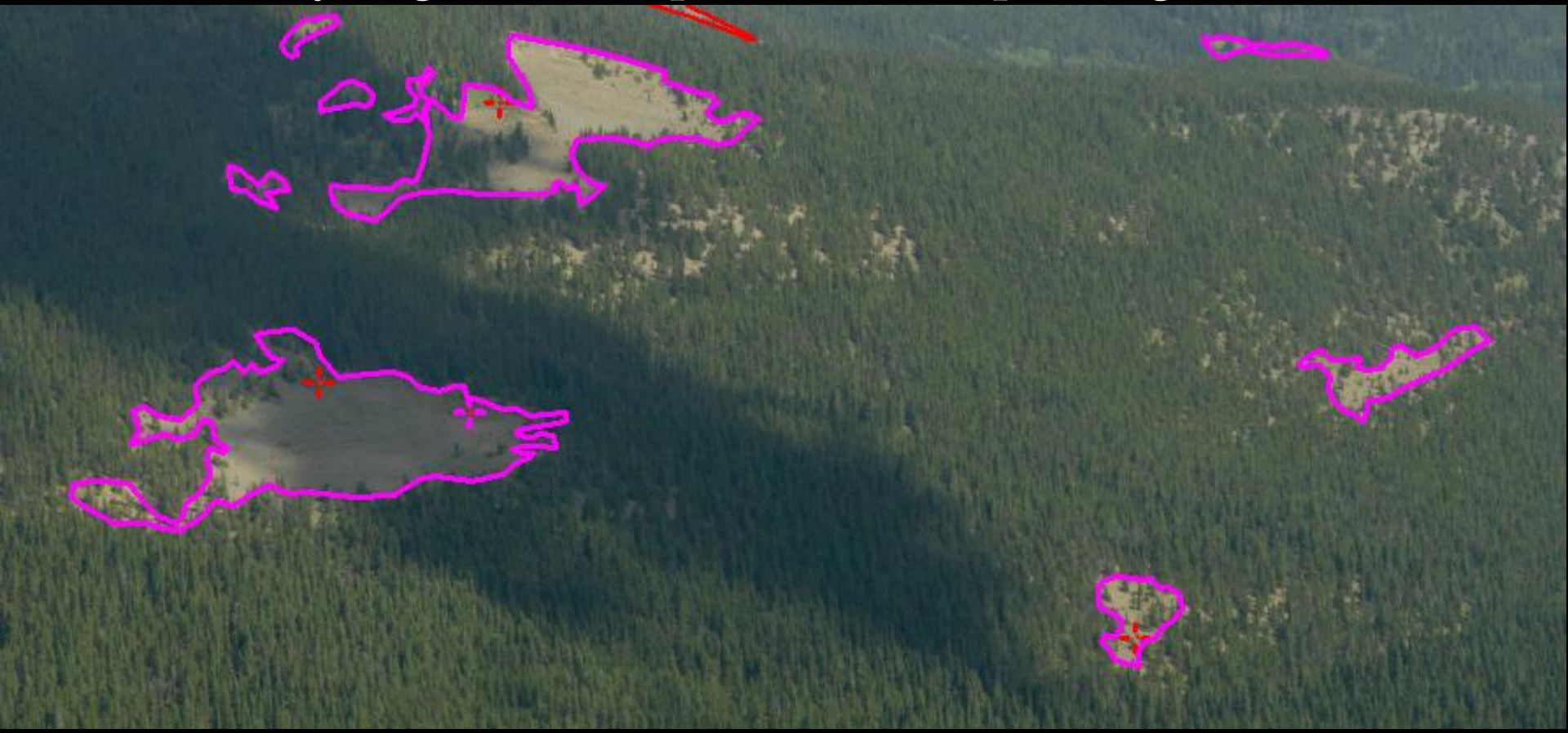


How do we use this to analyse landscape change?

1. Polygon based approach
2. Raster based approach
3. Hybrid polygon/raster

Polygons

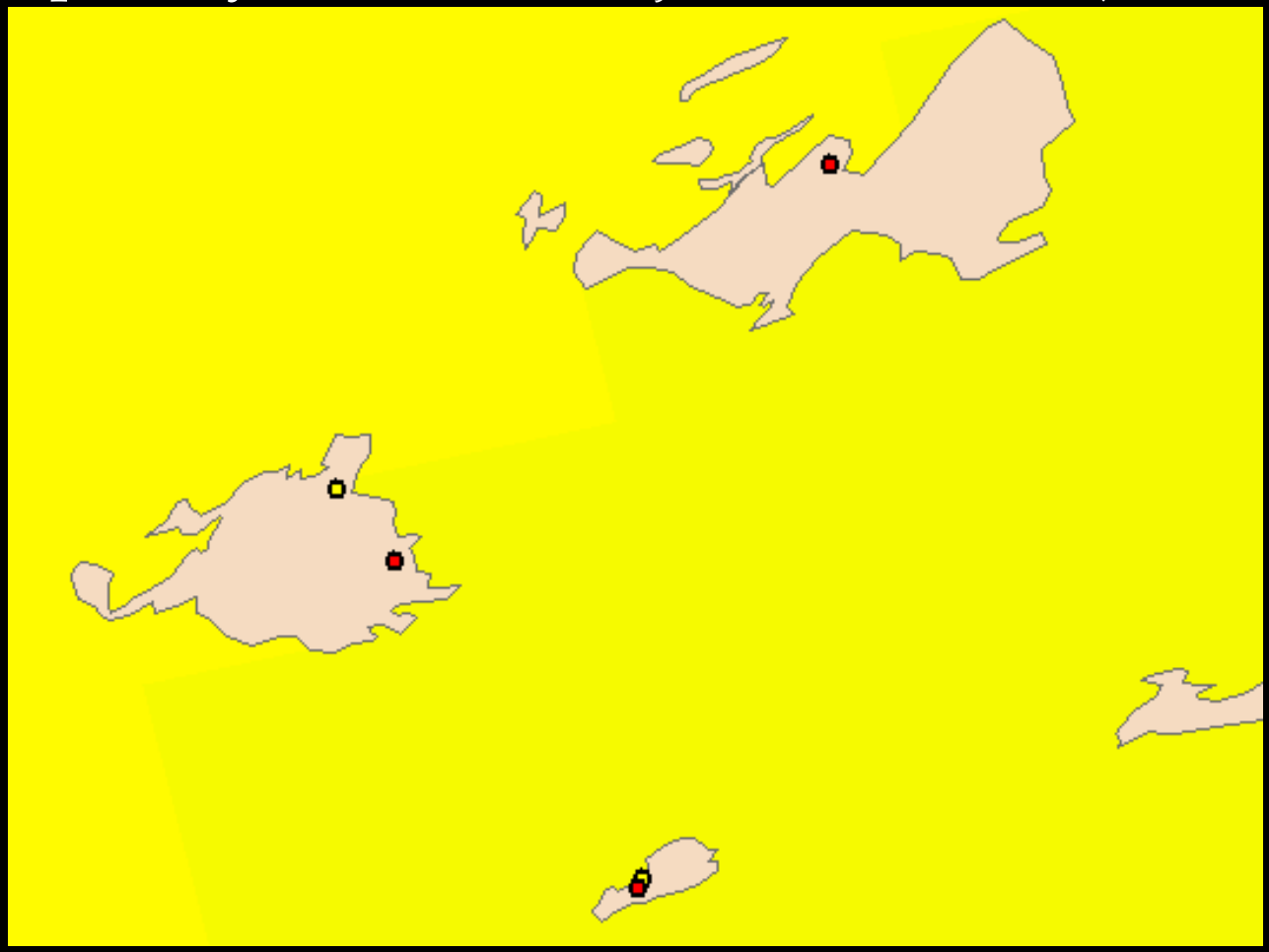
Classify vegetation in plots in Monoplotting Tool



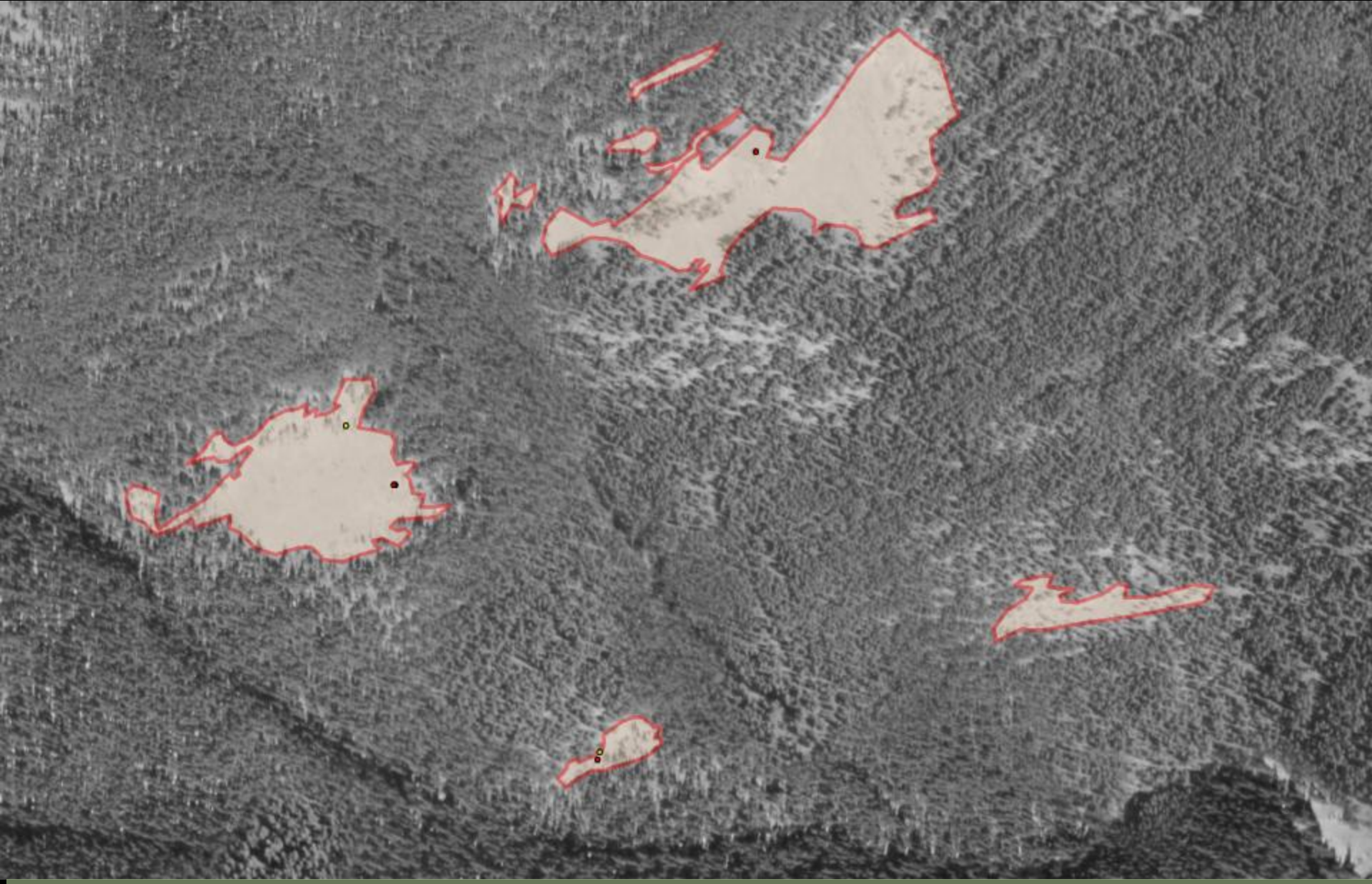
NOTE: Oblique view, MLP image

Polygons

Export spatially referenced objects to ArcGIS (or other GIS)



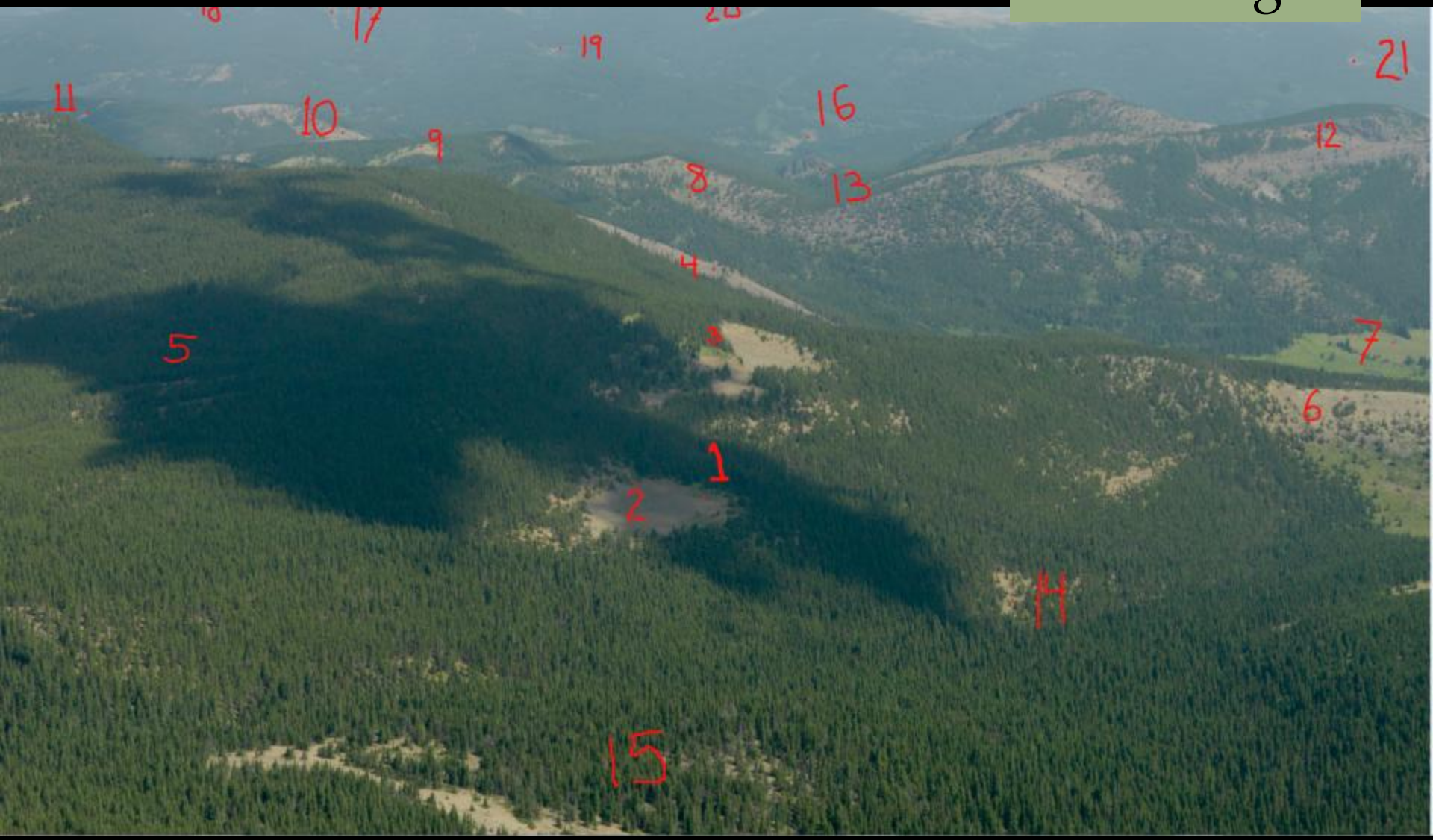
NOTE: Orthogonal view in GIS



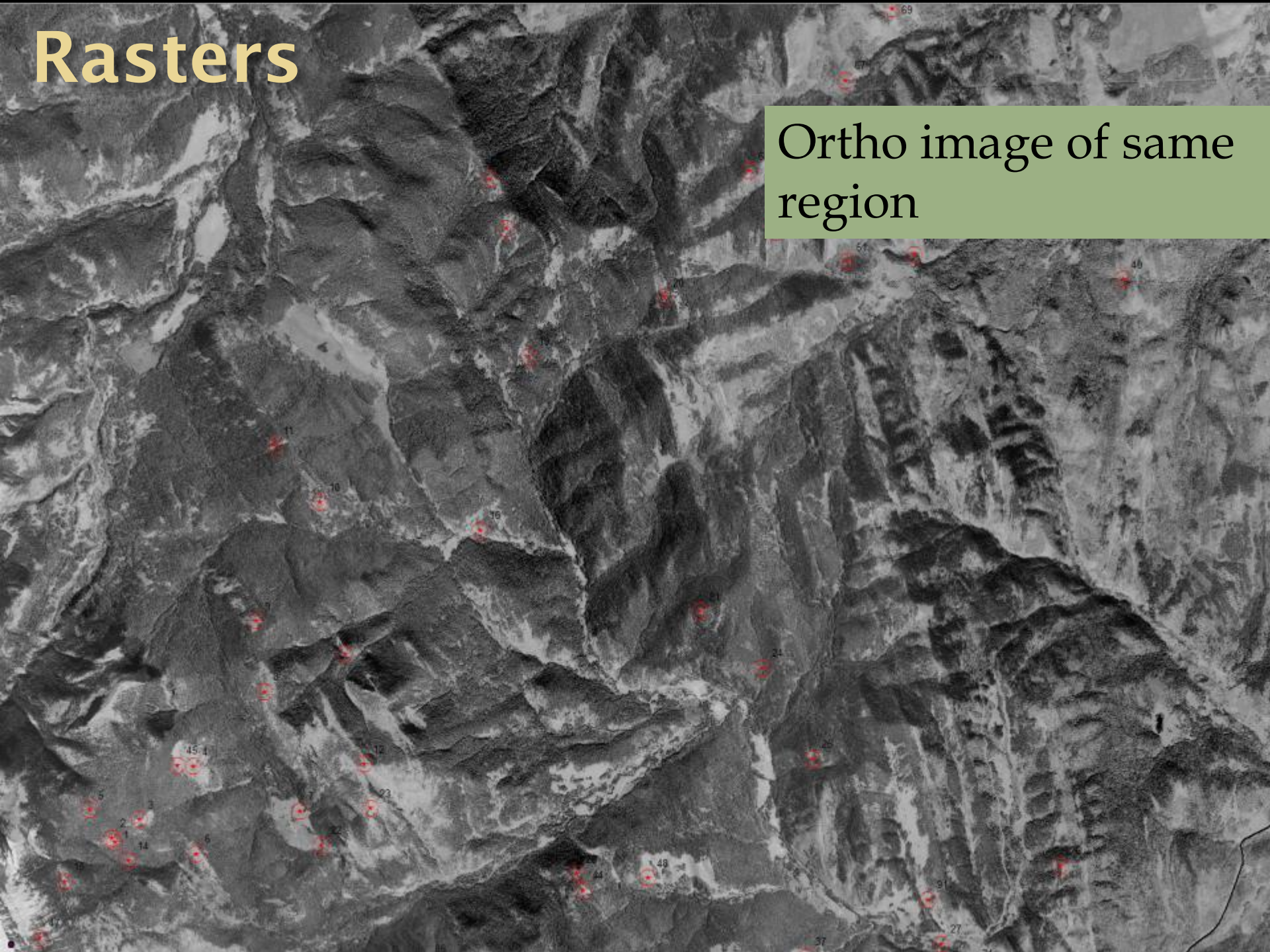
NOTE: Orthogonal view in GIS overlain on Orthophoto of same time as MLP image

Rasters

MLP image



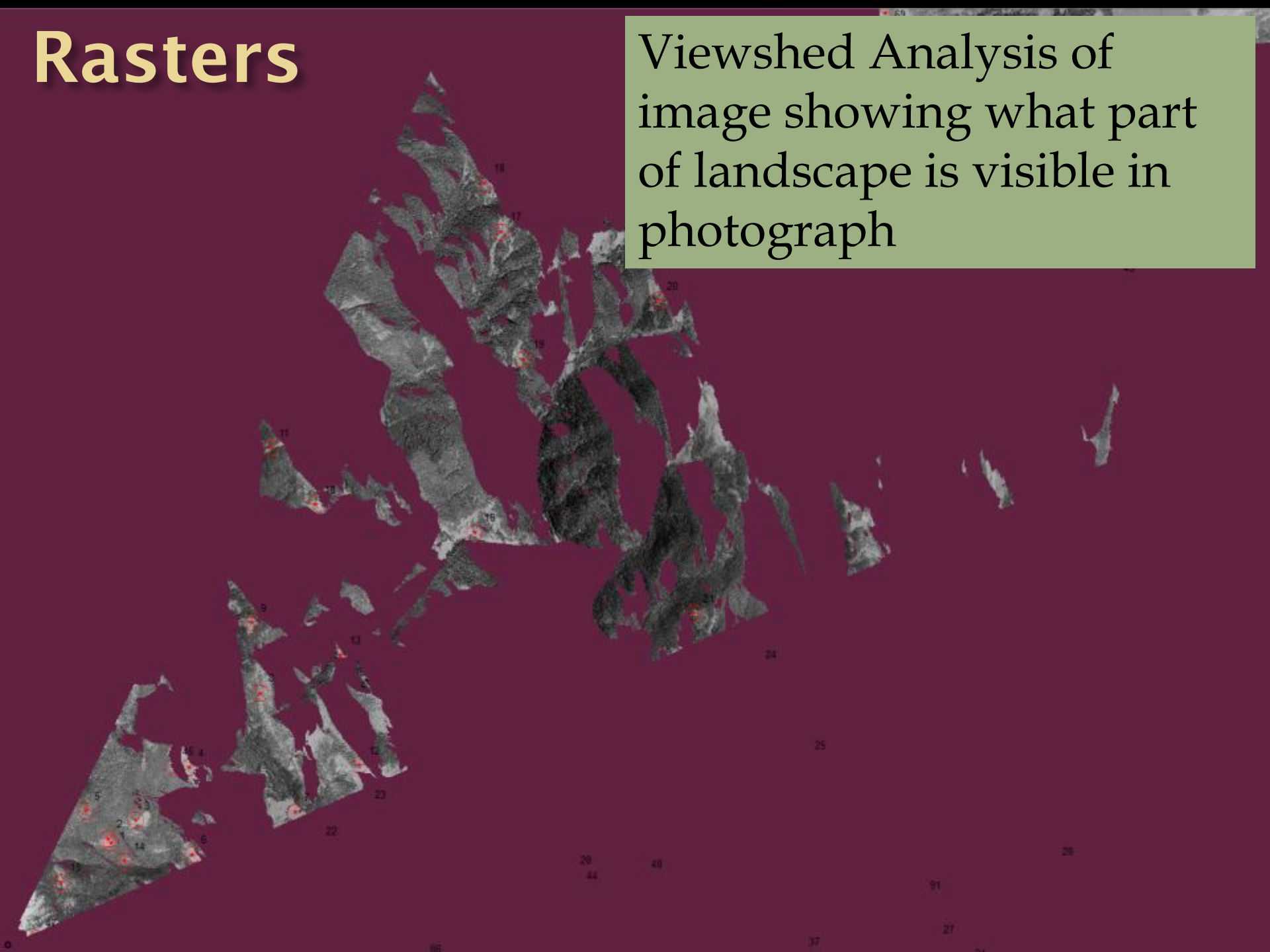
Rasters



Ortho image of same region

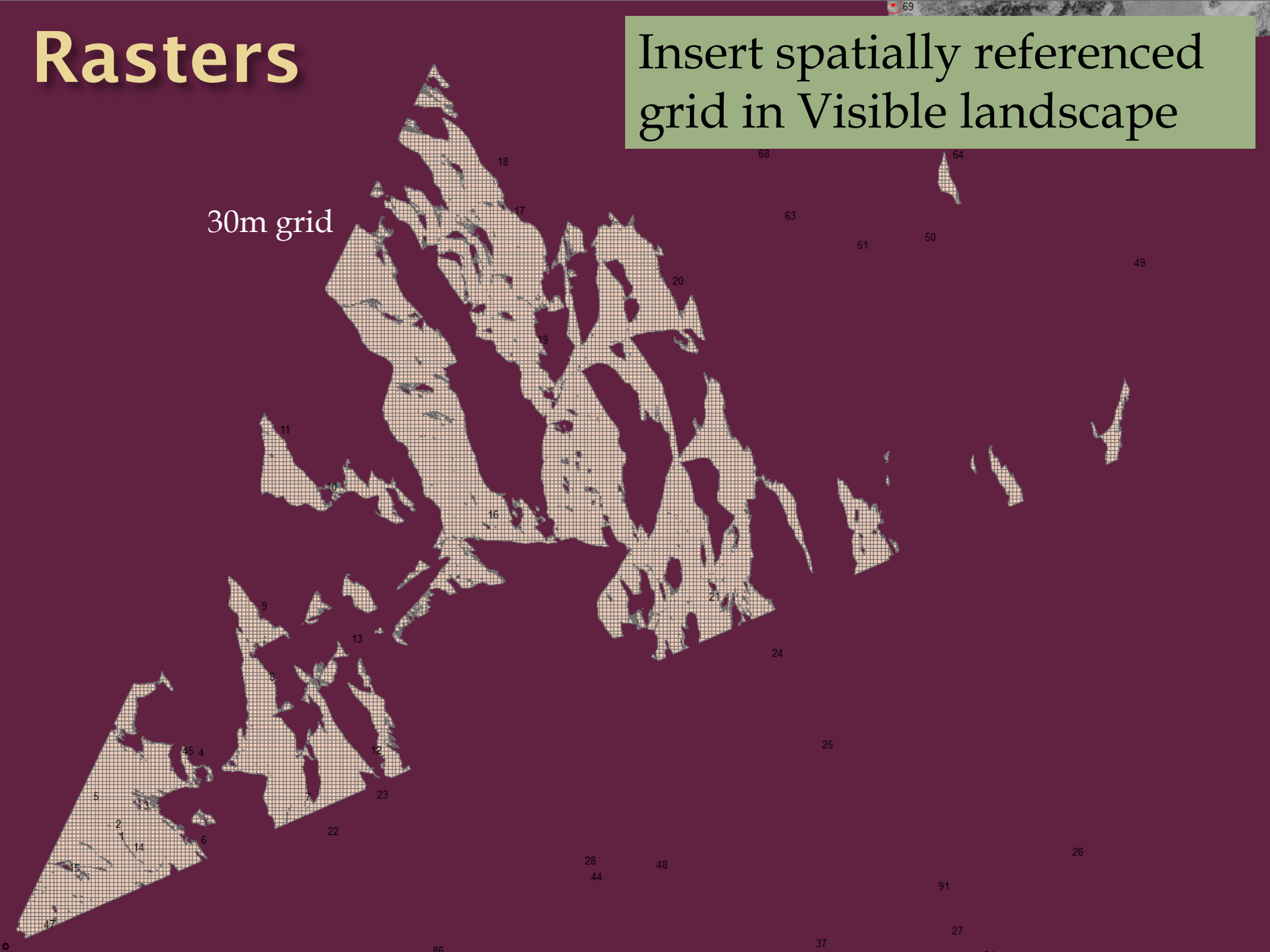
Rasters

Viewshed Analysis of image showing what part of landscape is visible in photograph



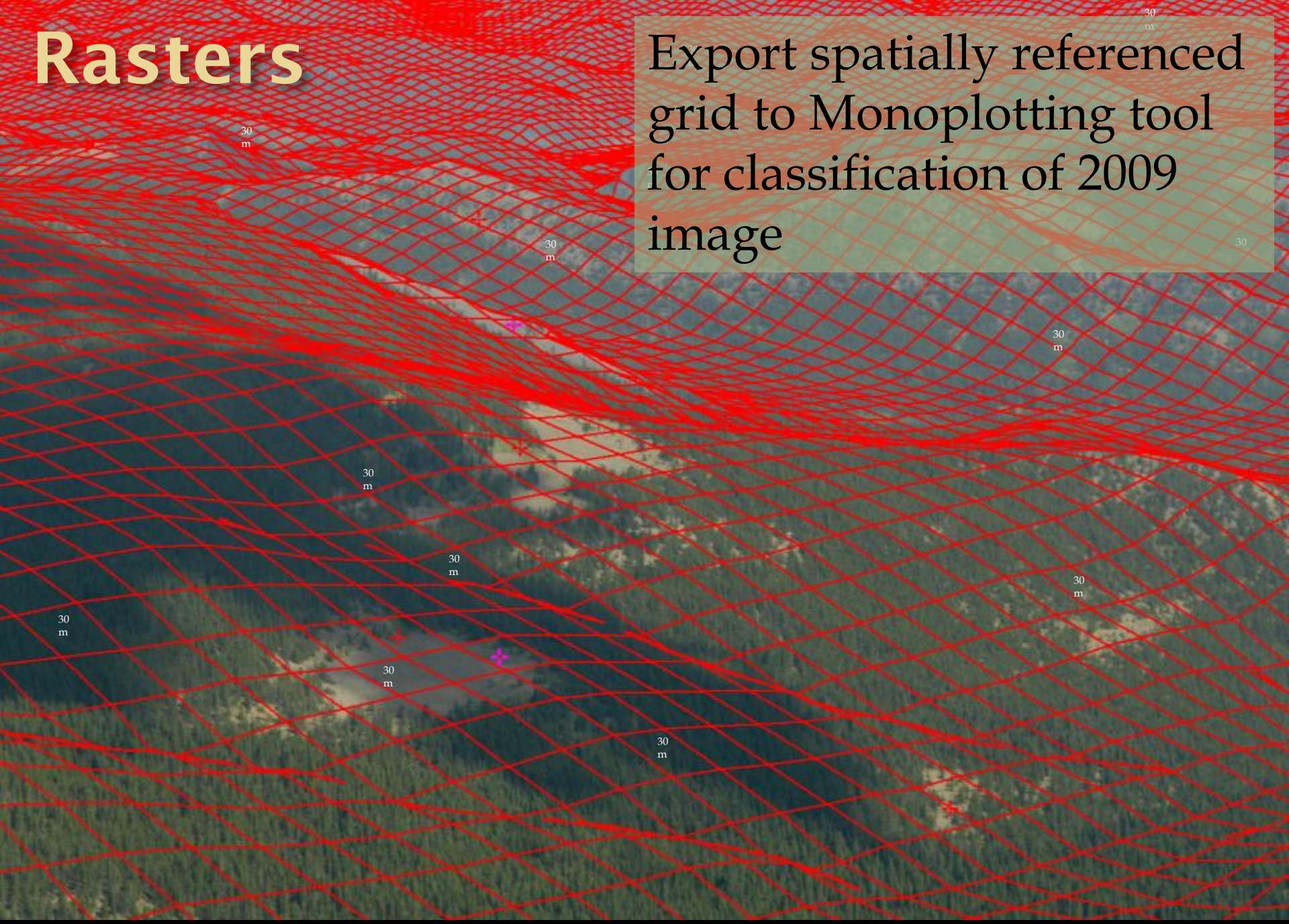
Rasters

Insert spatially referenced grid in Visible landscape

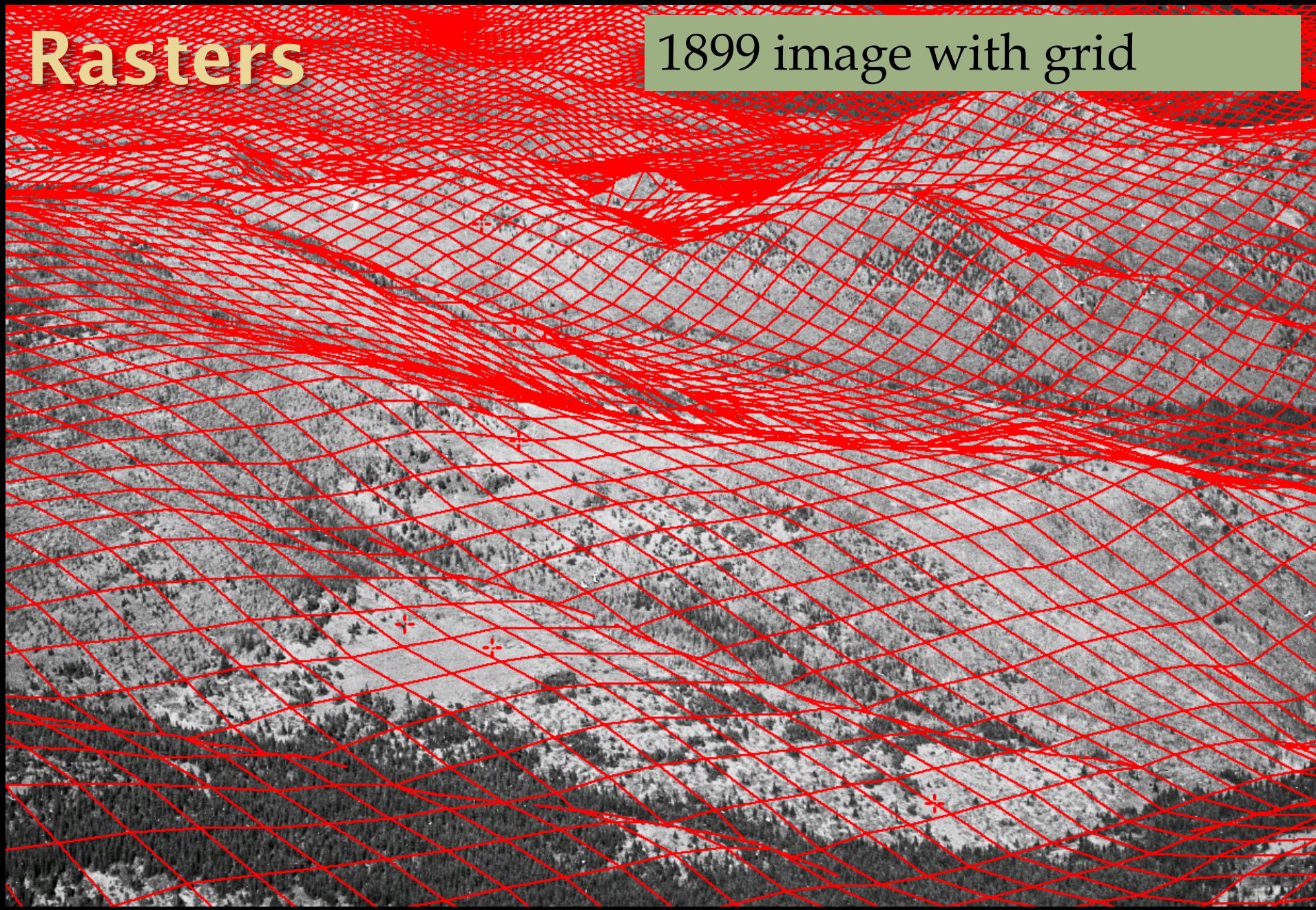


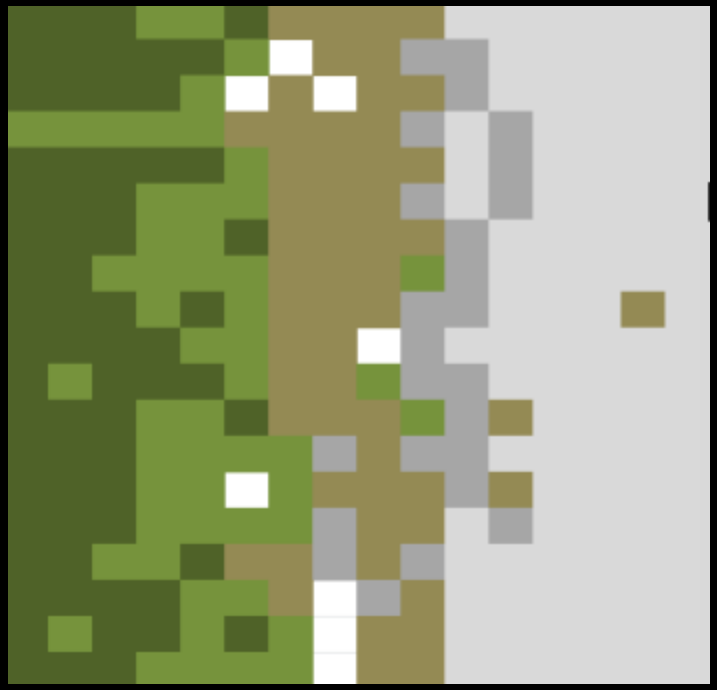
Rasters

Export spatially referenced grid to Monoplotting tool for classification of 2009 image



Rasters





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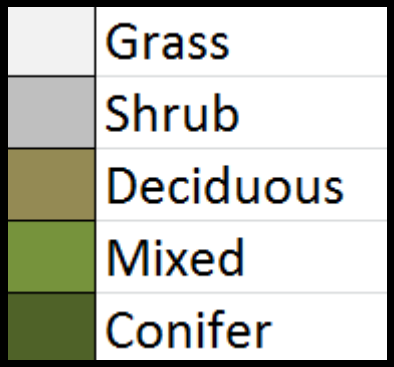

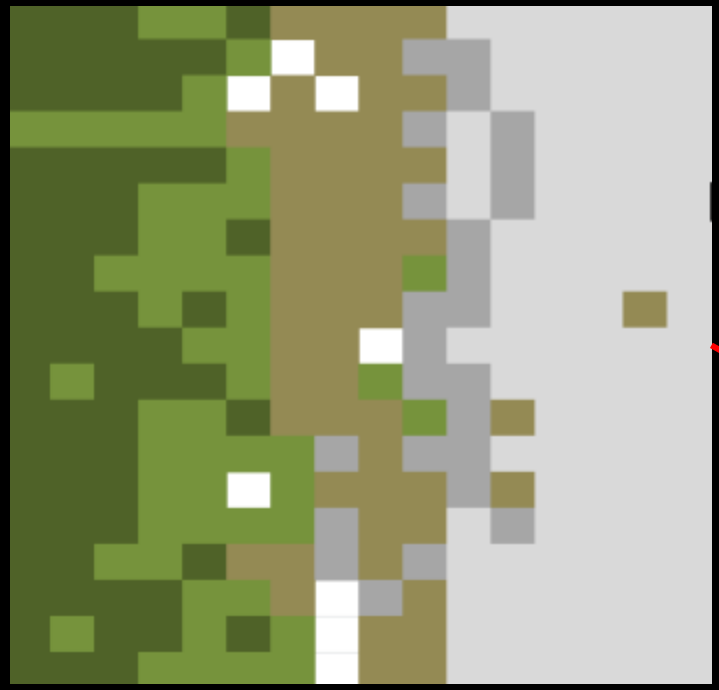

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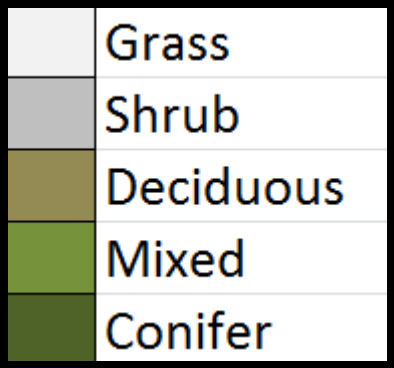


2009

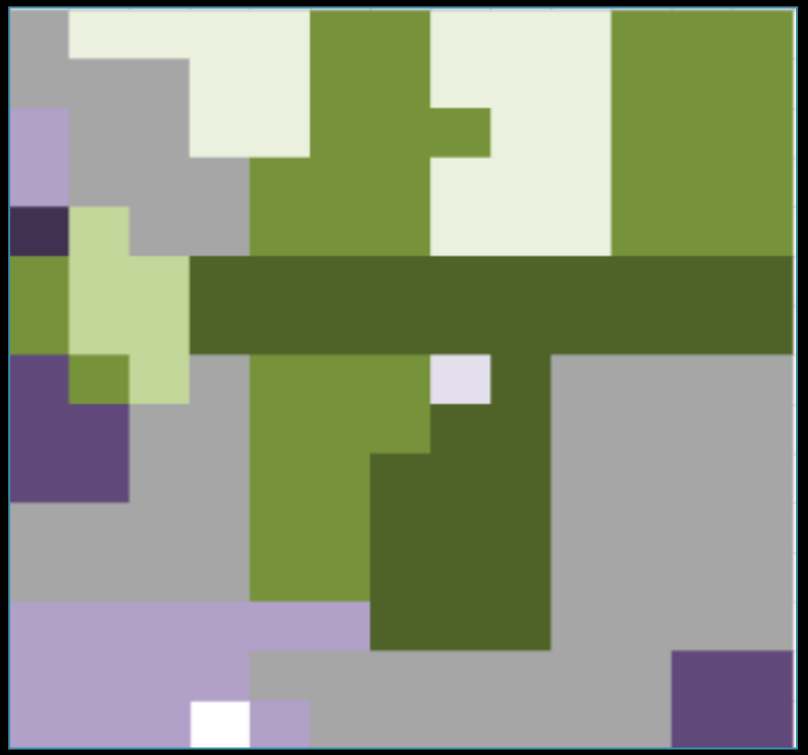
Table 1: Vegetation Transition Matrix

Initial Final	Grass	Shrub	Decid.	Mixed	Conifer
Grass	0	-1	-2	-3	-4
Shrub	1	0	-1	-2	-3
Deciduous	2	1	0	-1	-2
Mixed	3	2	1	0	-1
Conifer	4	3	2	1	0

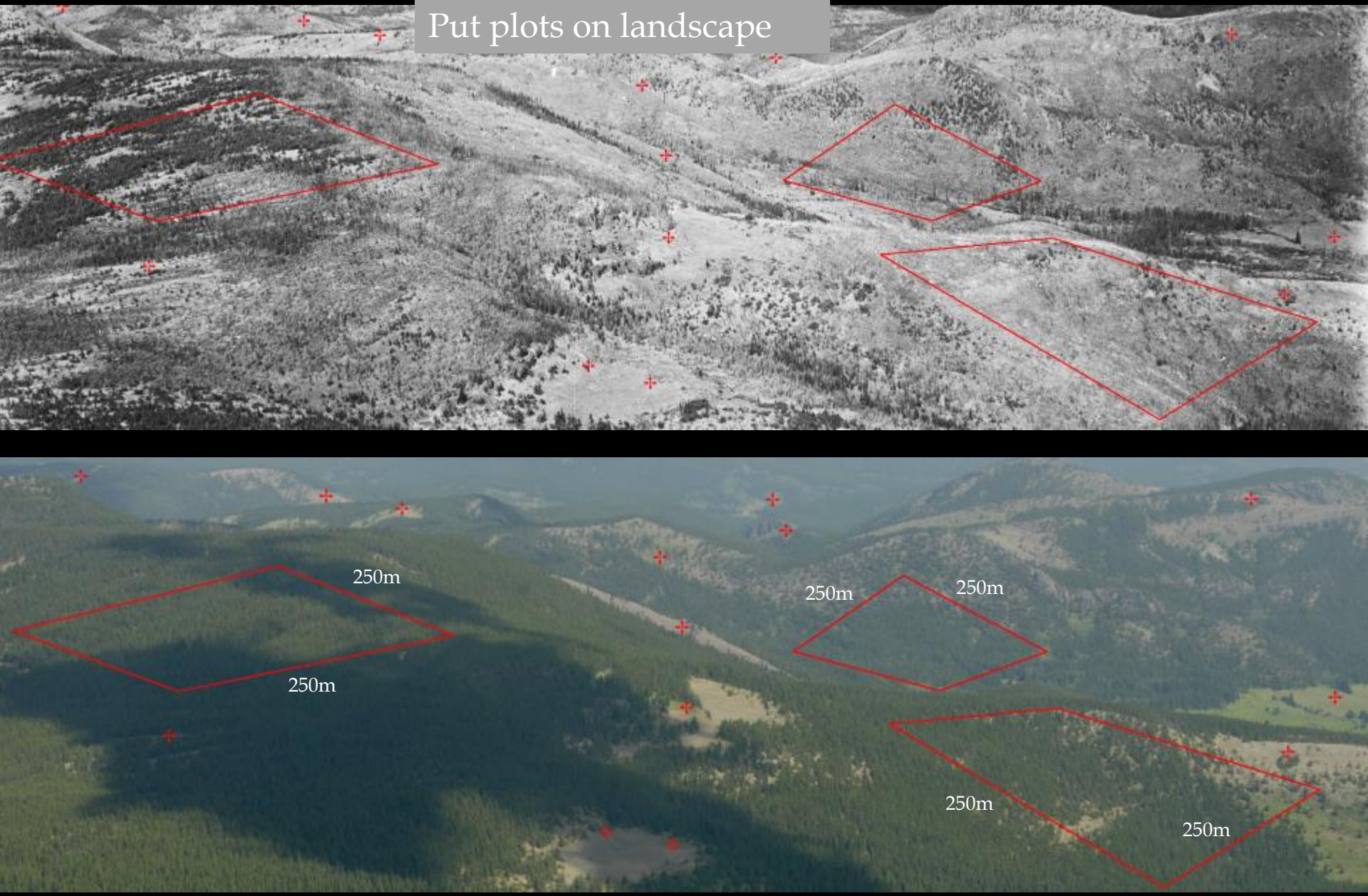
Table 1: Vegetation Transition Matrix

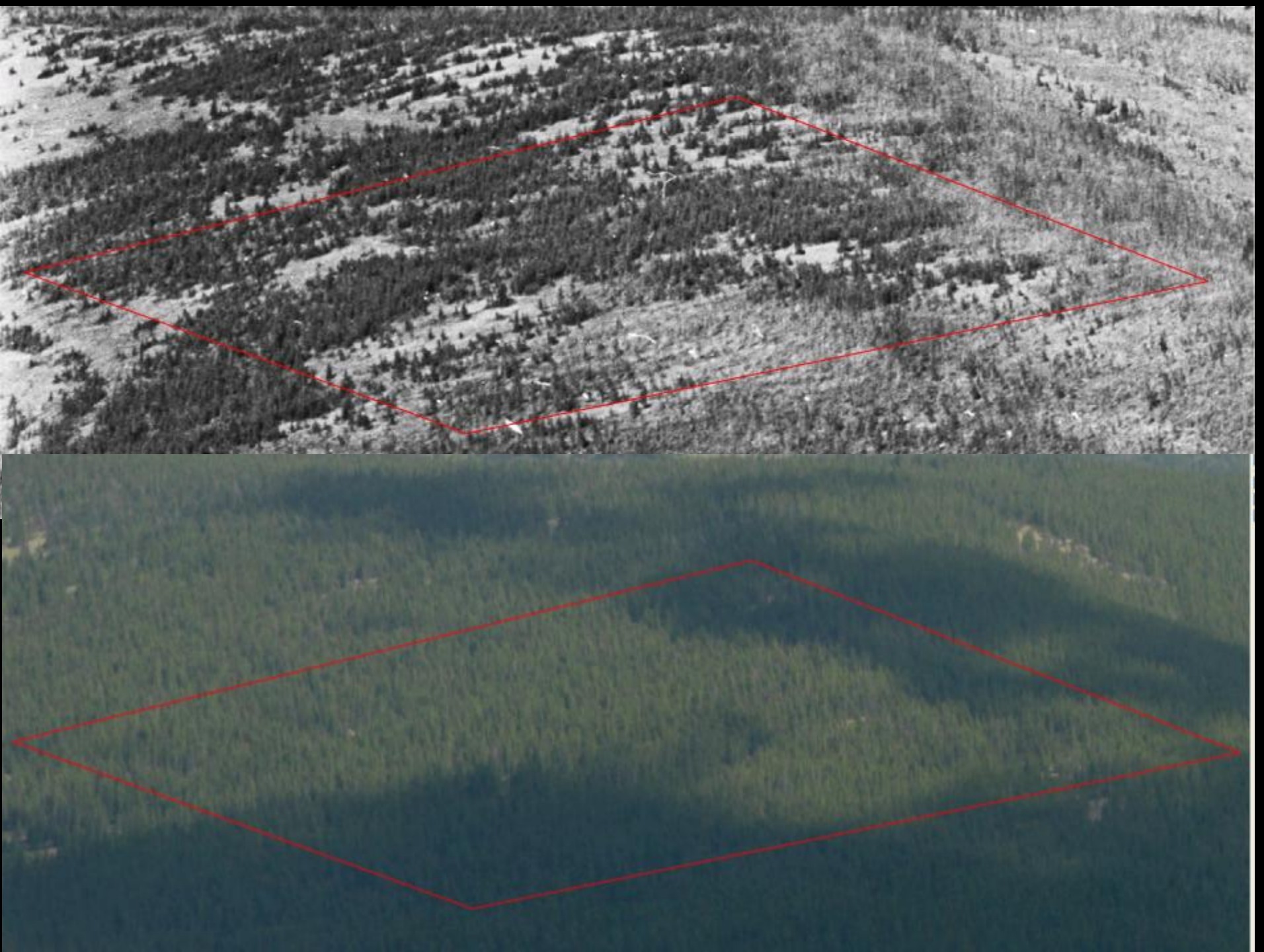
Initial Final	Grass	Shrub	Decid.	Mixed	Conifer
Grass	0	-1	-2	-3	-4
Shrub	1	0	-1	-2	-3
Deciduous	2	1	0	-1	-2
Mixed	3	2	1	0	-1
Conifer	4	3	2	1	0

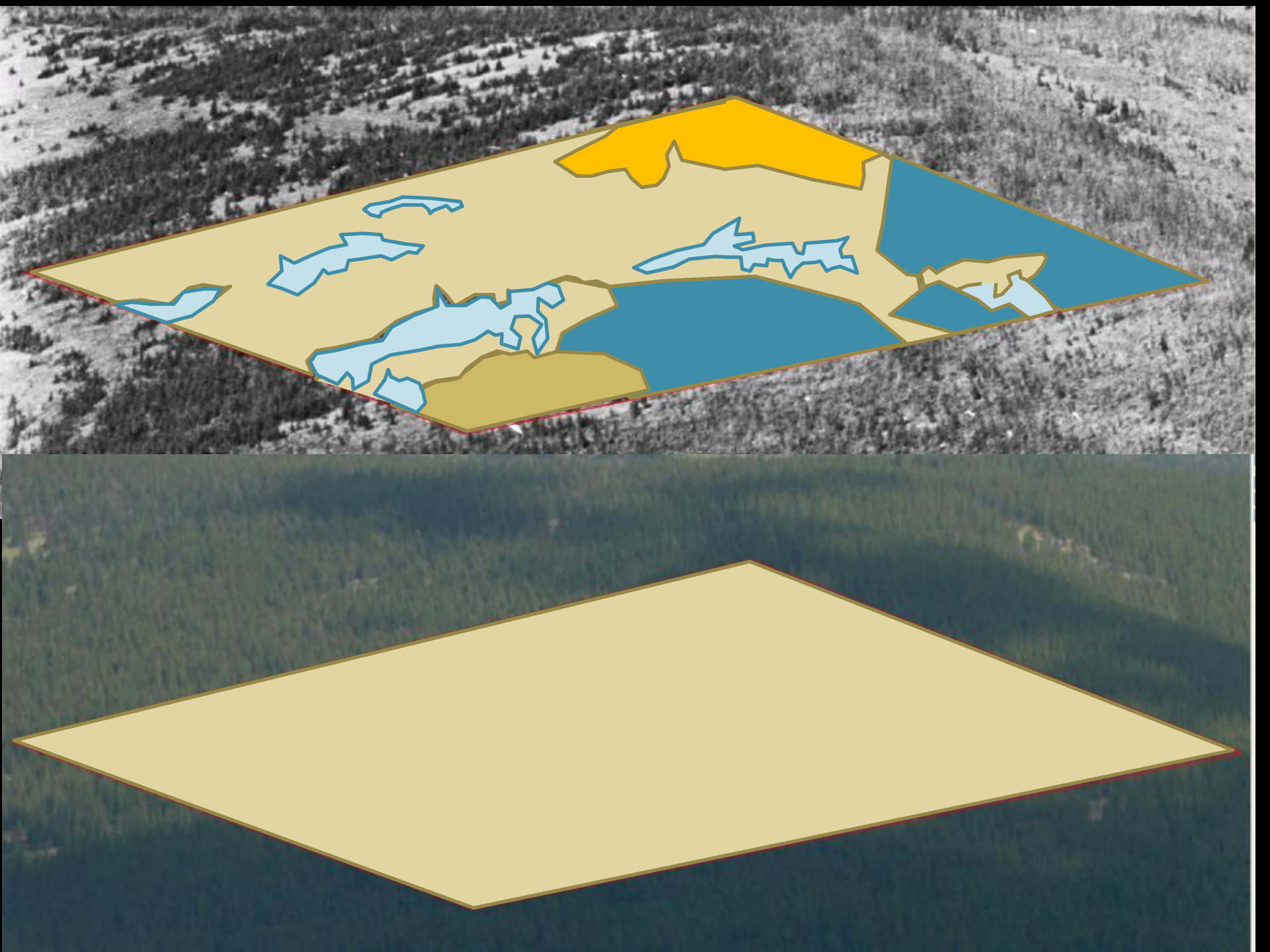
Figure 1: Raster "change" surface



Put plots on landscape







Is 1913 more variable than 2009?

Patch sizes, edge to interior, # of patches, fractal dimension, contagion, TPSA

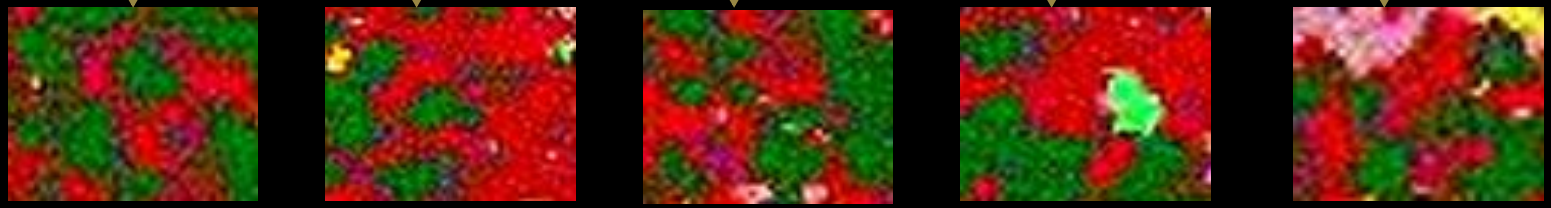
Has the leading tree species of the forest changed?

Where? Is this to more or less advanced successional species?

1913

Note: Mock classified imagery

2009



Is the forest more dense (stem density) in 2009 than 1913?

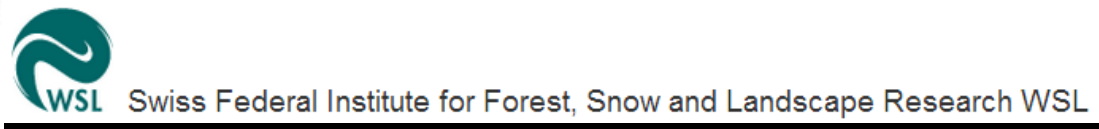
Where is this observed? What were the original conditions?

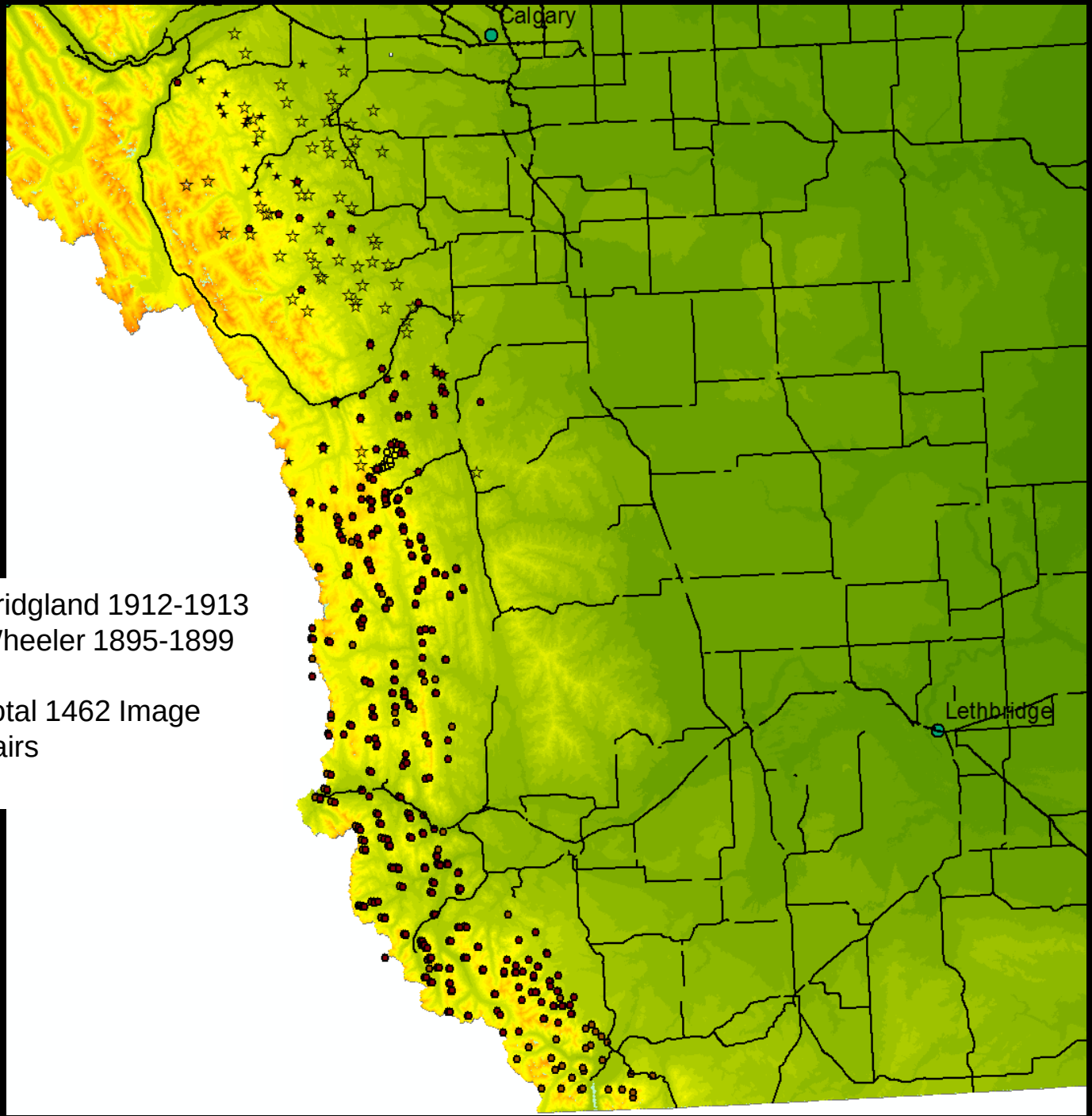
Is the age class distribution of the forest older and more homogenous?

Primary Funding Sources

Additional Funding Sources

In-Kind Support

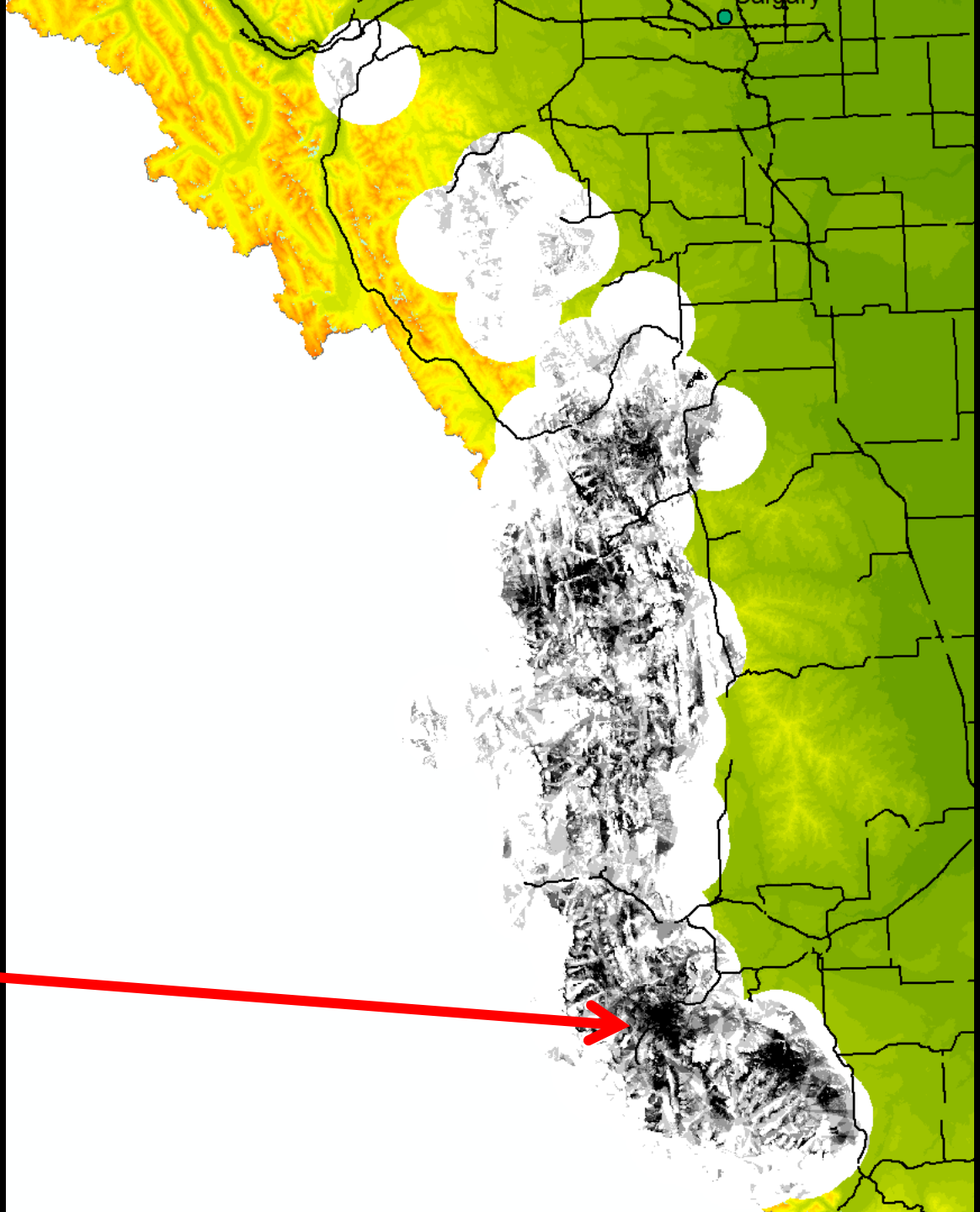




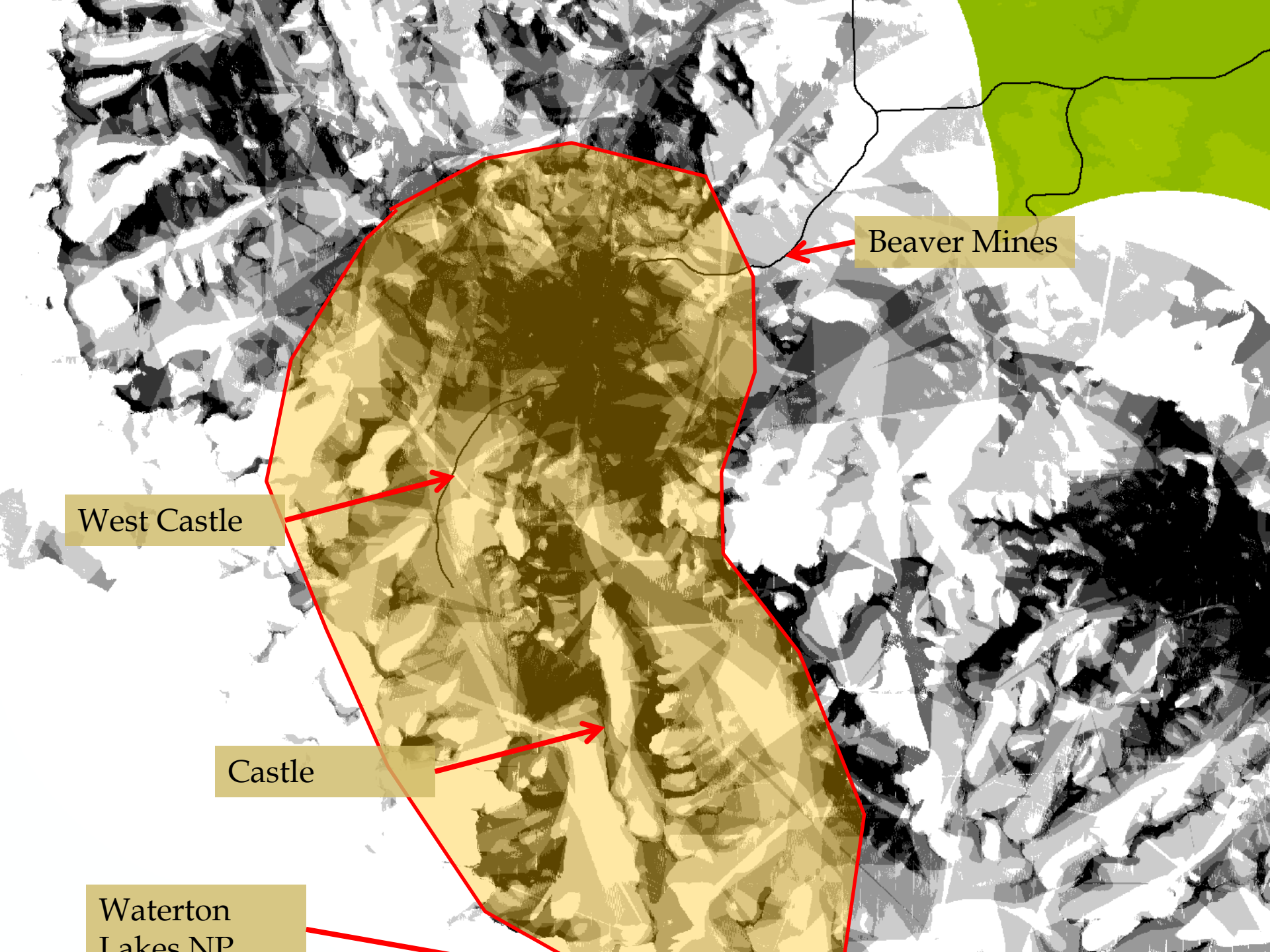
- Bridgland 1912-1913
- Wheeler 1895-1899

- Total 1462 Image pairs

5 km viewshed from all photos



Choose area with extensive view coverage


Beaver Mines
West Castle
Castle
Waterton
Lakes NP