Proposed methods for monitoring forest canopy spatial structure

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On behalf of the FR-CFLRP Spatial Heterogeneity sub-group

Thanks to:
Rob Addington, Greg Aplet, Tony Cheng, Jonas Feinstein & Ben Wudtke & Spatial Heterogeneity Subgroup

Outline

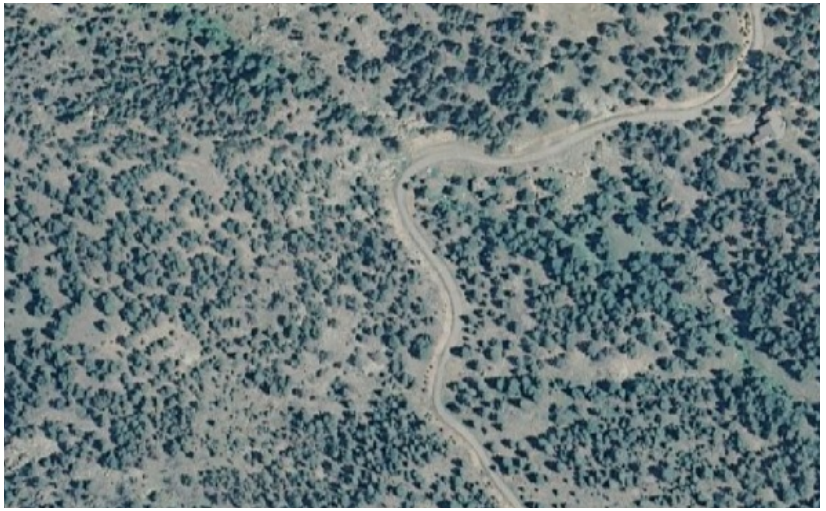
- Background
- Proposed methods for within-stand spatial structure
  - Aerial imagery methods
- Preliminary ideas for landscape-scale monitoring
- Group discussion

Background

- Spatial pattern a concern
- But – desired spatial pattern not defined
  - Many subgroups are working on projects that will inform DCs
- In meantime, need to develop monitoring protocol

Monitoring forest conditions within treatments

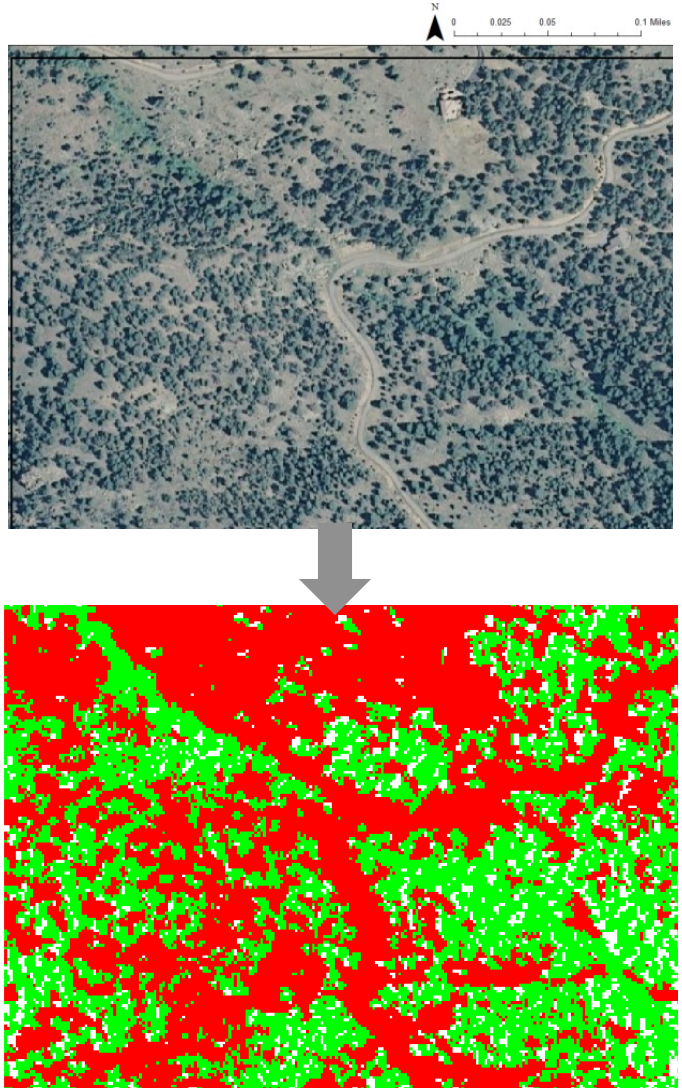
- Multiple data sources:
  - Basic forest inventory information
    - CSE data
  - Spatial structure
    - Transects to quantify openings
      - Jonas will discuss later today
    - **Aerial imagery**
      - **Can see & quantify canopy cover pattern**



Aerial imagery methods overview

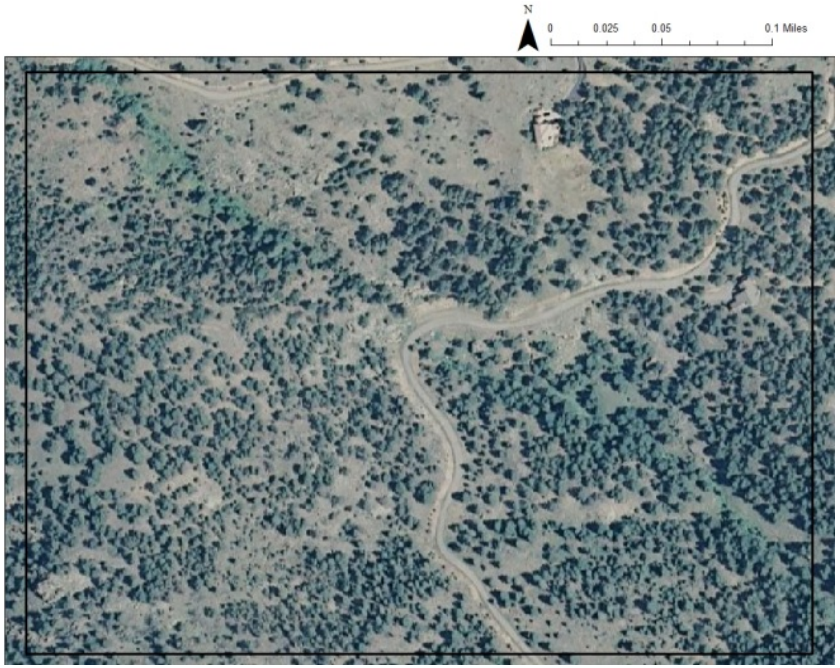
- Use NAIP (National Agriculture Imagery Program) data
  - 1 m resolution
  - 4 band (R, G, B, and near-IR)
  - Free
- Classify image so have "canopy cover" and "not canopy"
- Use FRAGSTATS to analyze canopy cover pattern
  - Patch size, shape, arrangement, etc.
- 4FRI independently designed a very similar method

- Example: Compare two ~58 acre patches

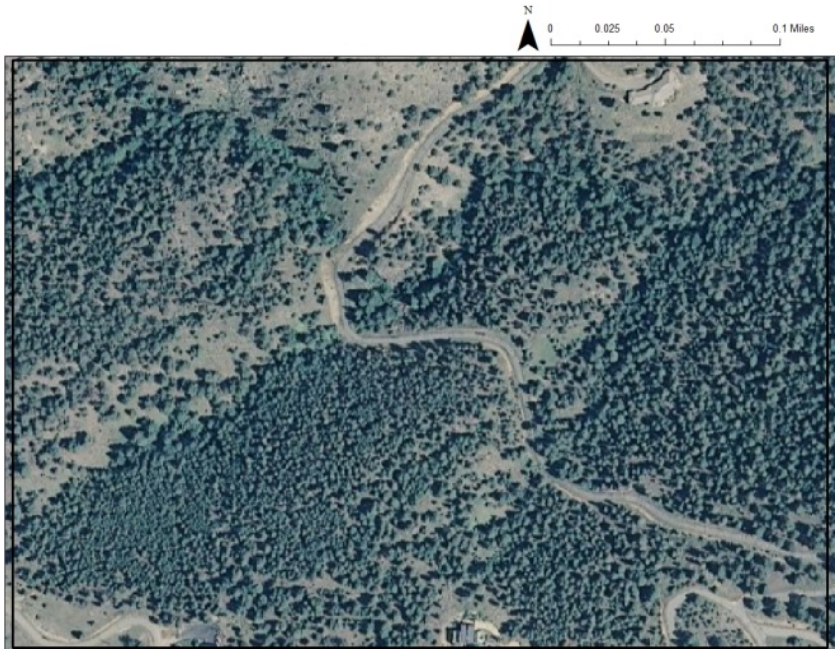


Example to test methods

Area #1



Area #2

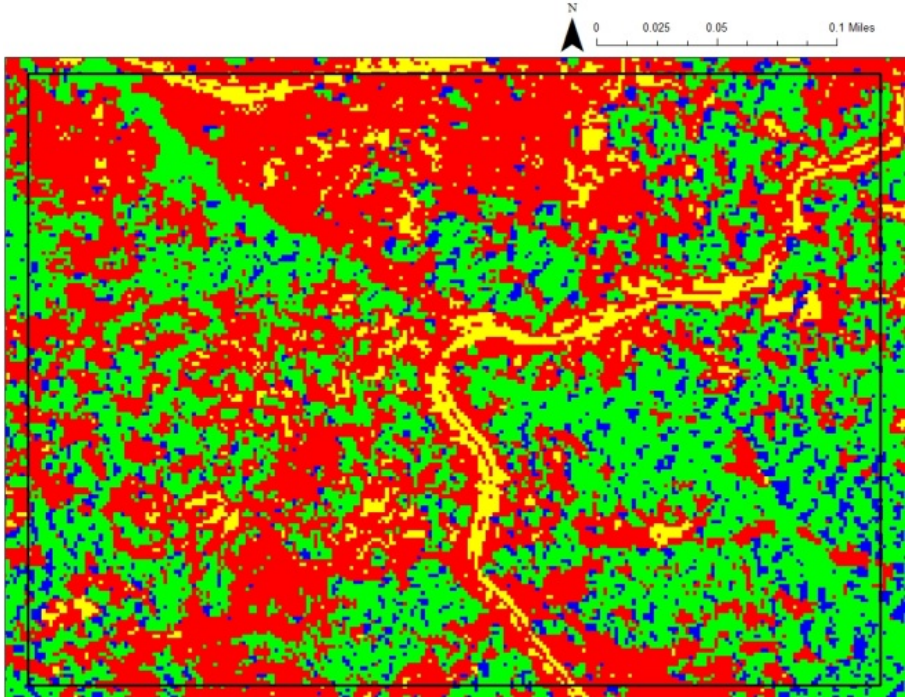


- 2 areas with obviously different forest spatial pattern
- Compare the FRAGSTATS outcome to see if it shows differences

Aerial imagery classification

Raw image

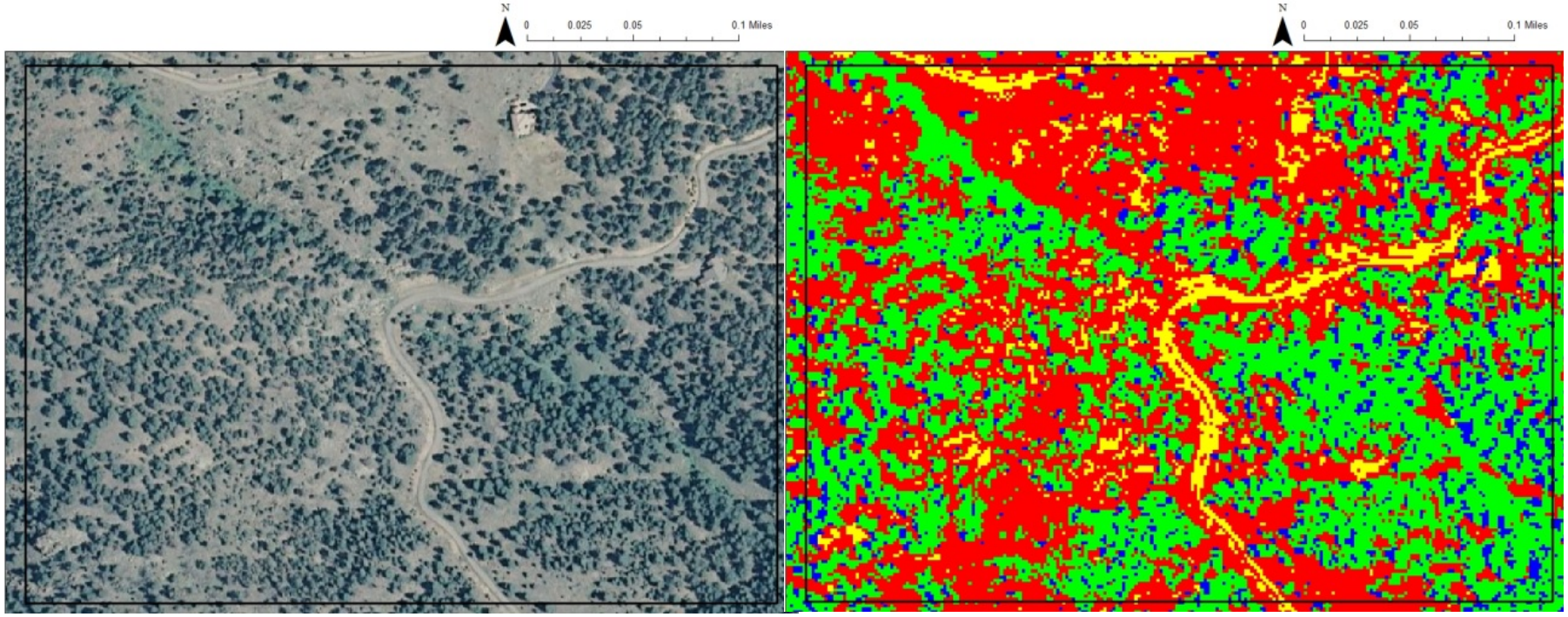
Classified image



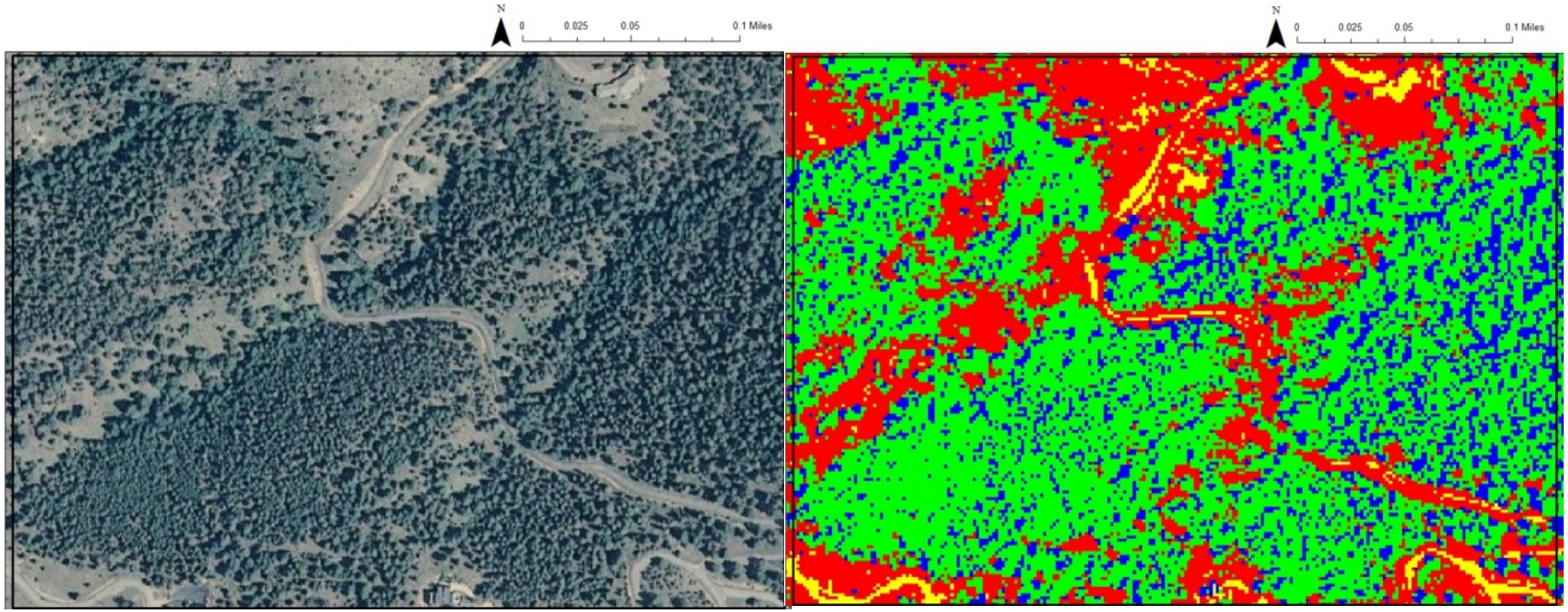
Conifer canopy
Other vegetation
Bare soil
Shadow

- 88% overall accuracy
- 87% accuracy for conifer classification

#1:


N
0
0.025
0.05
0.1 Miles
N
0
0.025
0.05
0.1 Miles

#2:


N
0
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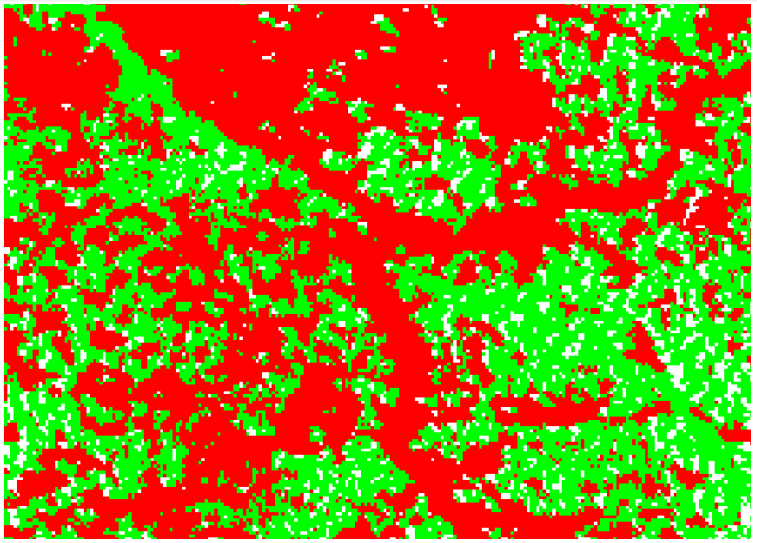
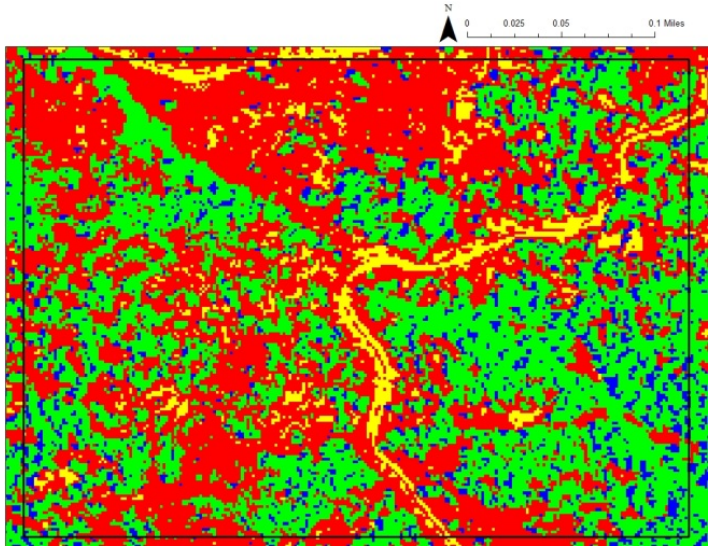
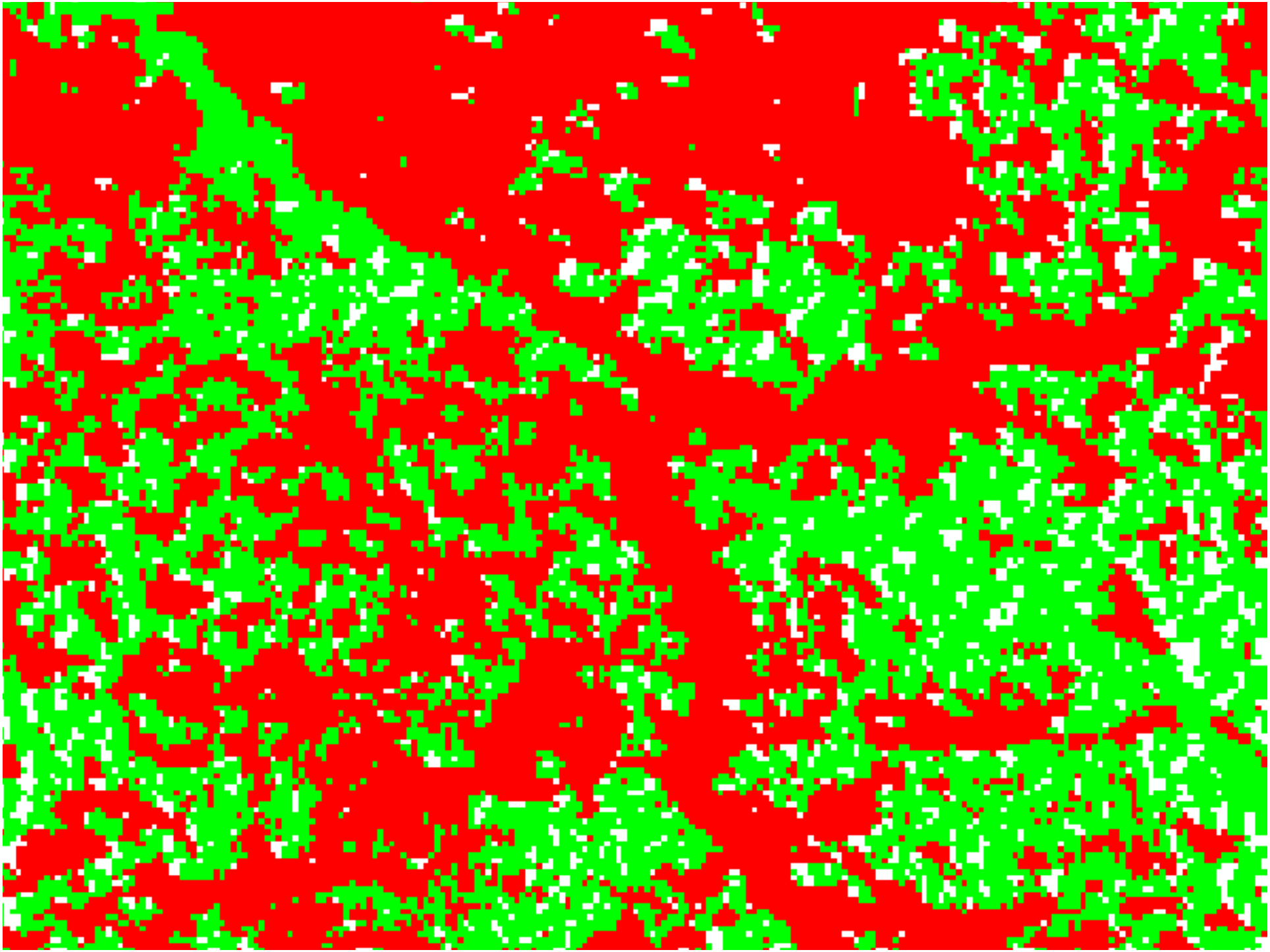
Reclassification & working around shadows

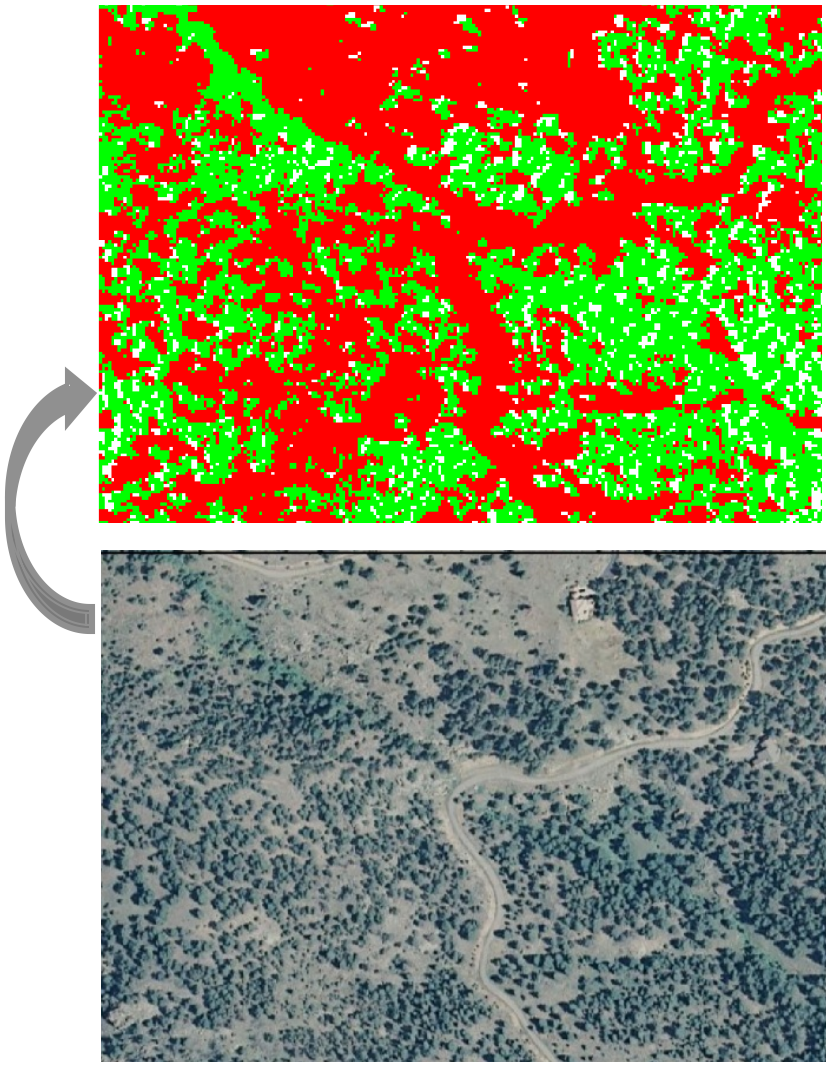
- Classify into coniferous canopy or openings
- Shadows ignored
  - Classified as nothing







FRAGSTATS Analysis

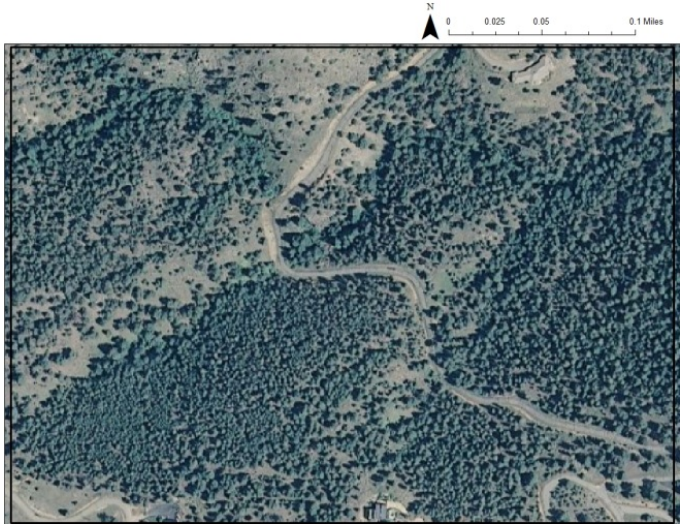


- Developed to quantify forest structure at landscape scale
- Quantifies patterns with metrics:
  - % of landscape
  - Patch density (/ha)
  - Largest patch index (%)
  - Edge density (m/ha)
  - Patch area (ha)
  - Perimeter : area
  - Proximity index
  - Euclidian nearest neighbor distance (m)

Results show differences between areas

#1:

#2:



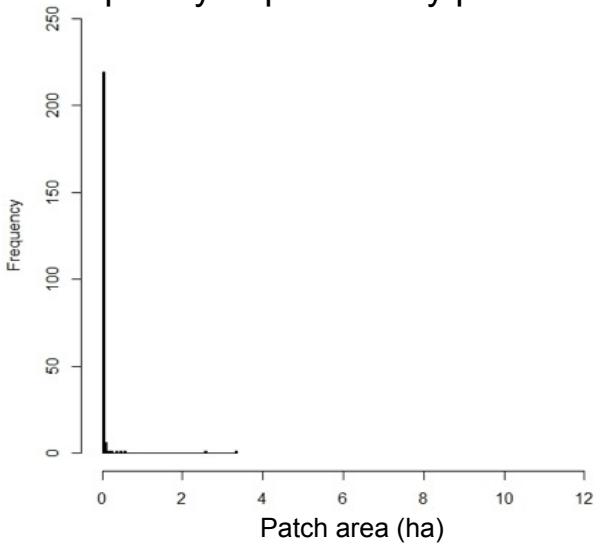
Comparison of canopy between Area 1 & 2.

		Area 1	Area 2
% of Landscape		42.52	65.95
Patch density (/ha)		1079	837
Largest patch index (%)		15.49	36.56
Edge density (m/ha)		1113	805
Patch area (ha)	*Mean*	0.0394	0.0788
	Range	3.3420	12.3800
	Std. dev.	0.2789	0.9665
Perimeter:area	*Mean*	11616	12796
	Range	13243	13052
	Std. dev.	4476	4056
Proximity index	*Mean*	331.1	2711.4
	Range	1452.0	5377.4
	Std. dev.	461.6	2326.9
Euclidian nearest neighbor distance (m)	*Mean*	6.40	6.0
	Range	20.26	15.6
	Std. dev.	3.13	2.5

Can generate distributions of canopy characteristics

#1:

Frequency of patches by patch area



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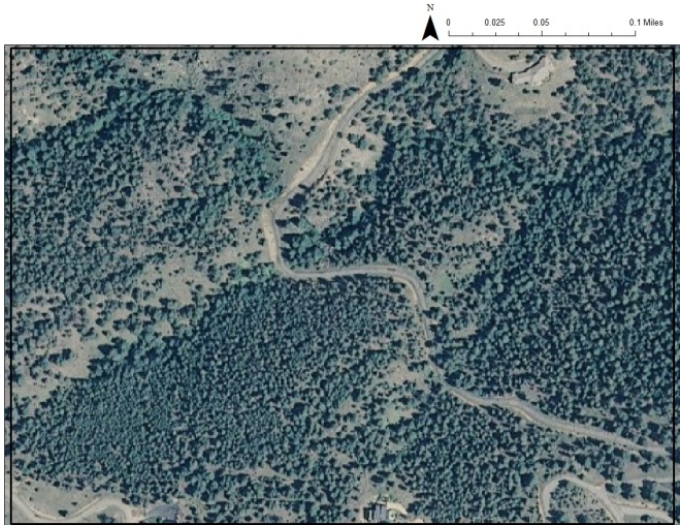
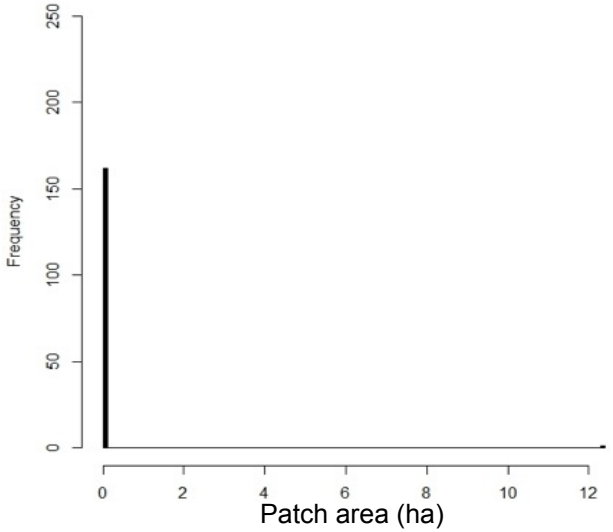
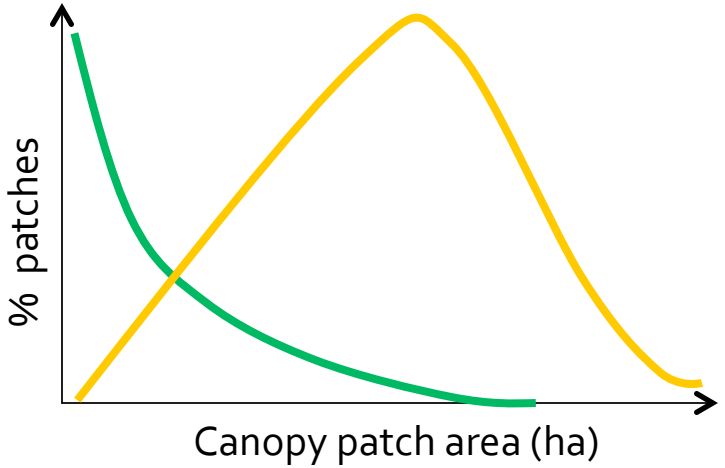
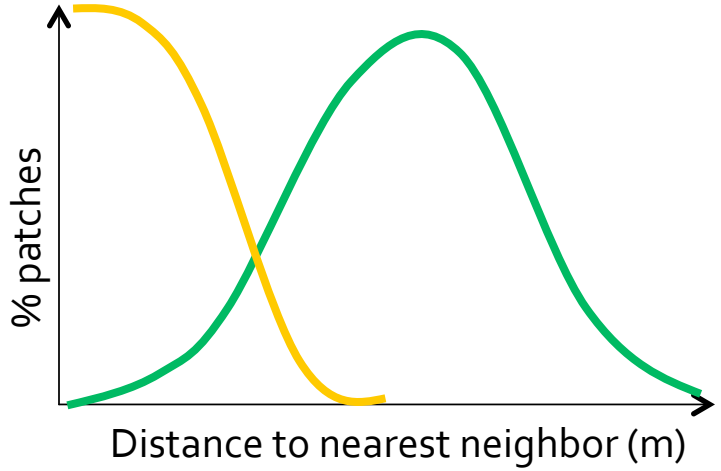




Use of these methods for monitoring

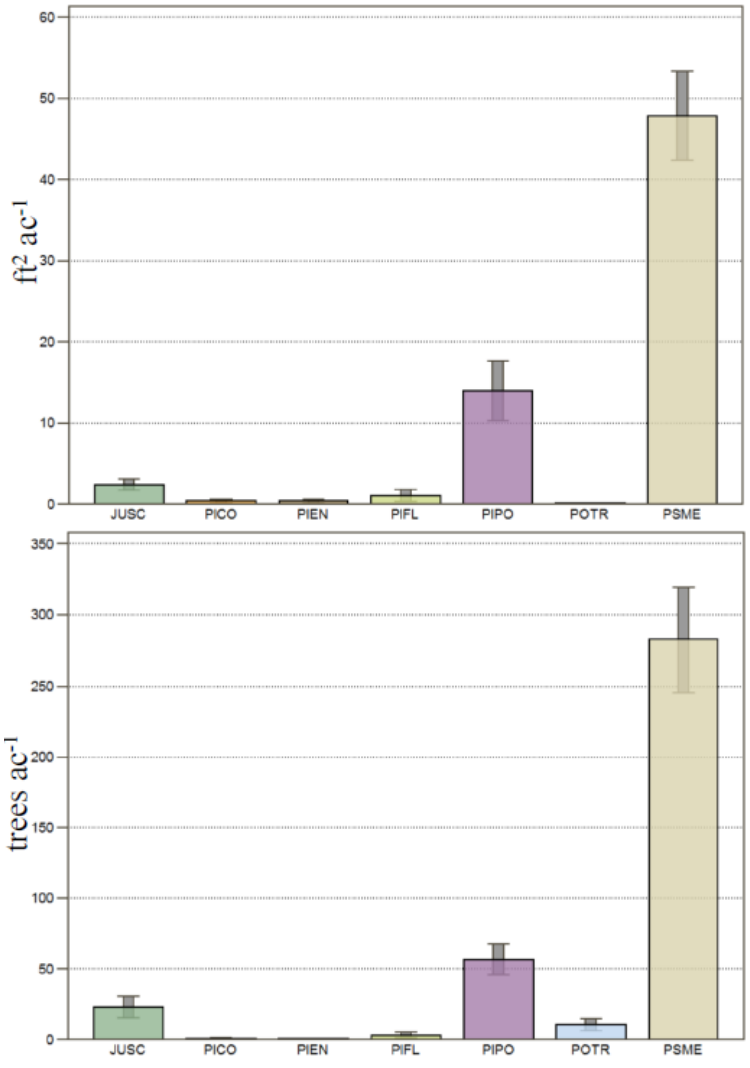
- Use these methods to compare units before and after treatment
- Then could compare existing forest to a range/distribution that *might* define "desired conditions"
- **Provide common language for discussing "groupy-clumpy" forest characteristics**
  - If we agreed on an area with desirable conditions we could then quantify pattern with FRAGSTATS metrics





Add CSE data to canopy pattern analysis

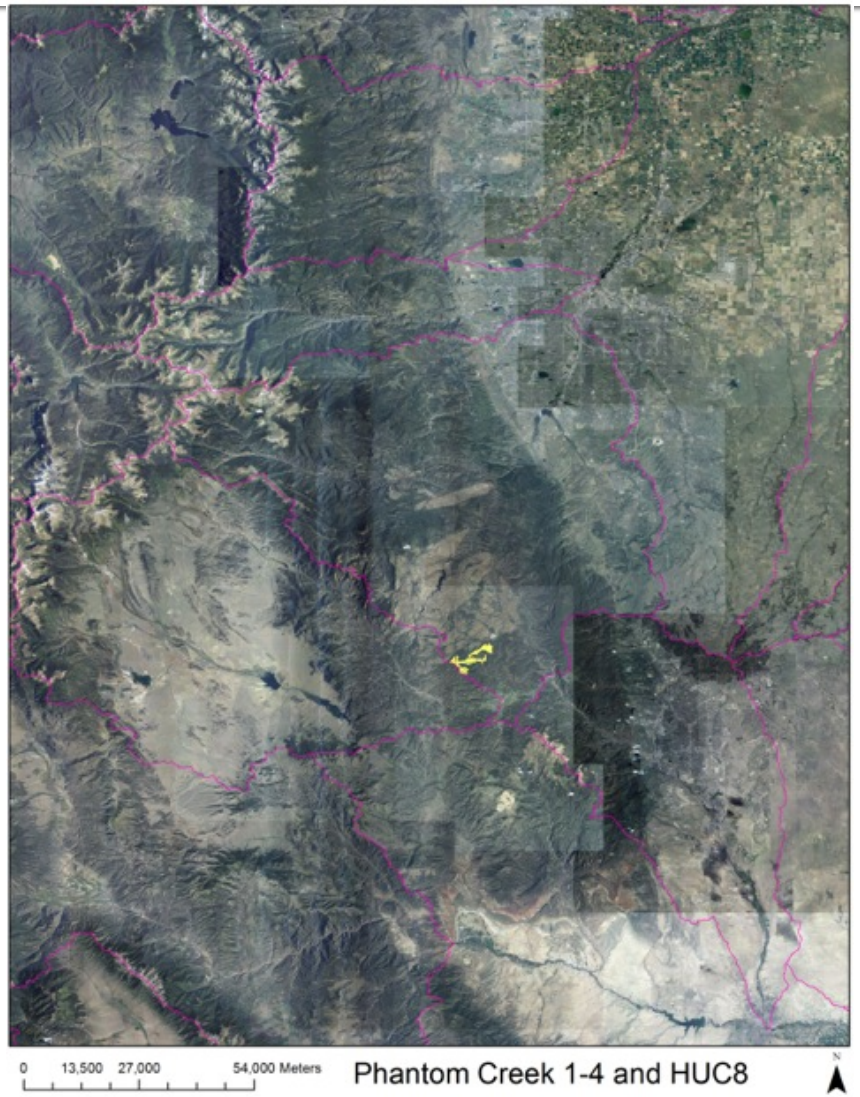
- Together, will provide a complete stand structure description
  - Move beyond stand means
    - Analyze at within- and between-plot level
    - Means, medians, minimums, maximums, and distributions of basal area, dbh, heights, densities, etc.



Graphs by Ben Wudtke, CFRI

Considerations for landscape-scale

- Define landscape size
  - Need to choose scale at which treatments will have an effect
- Define variables of interest
  - Canopy cover
- What data are freely available?



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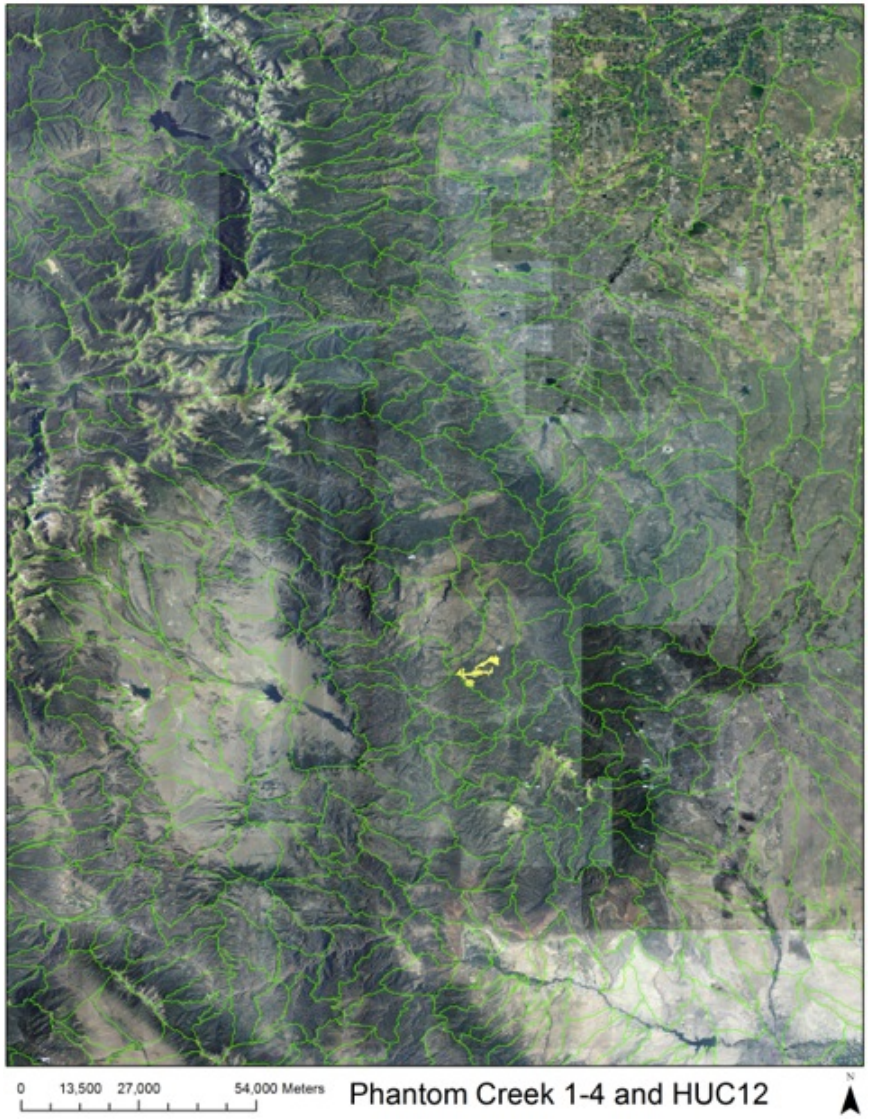

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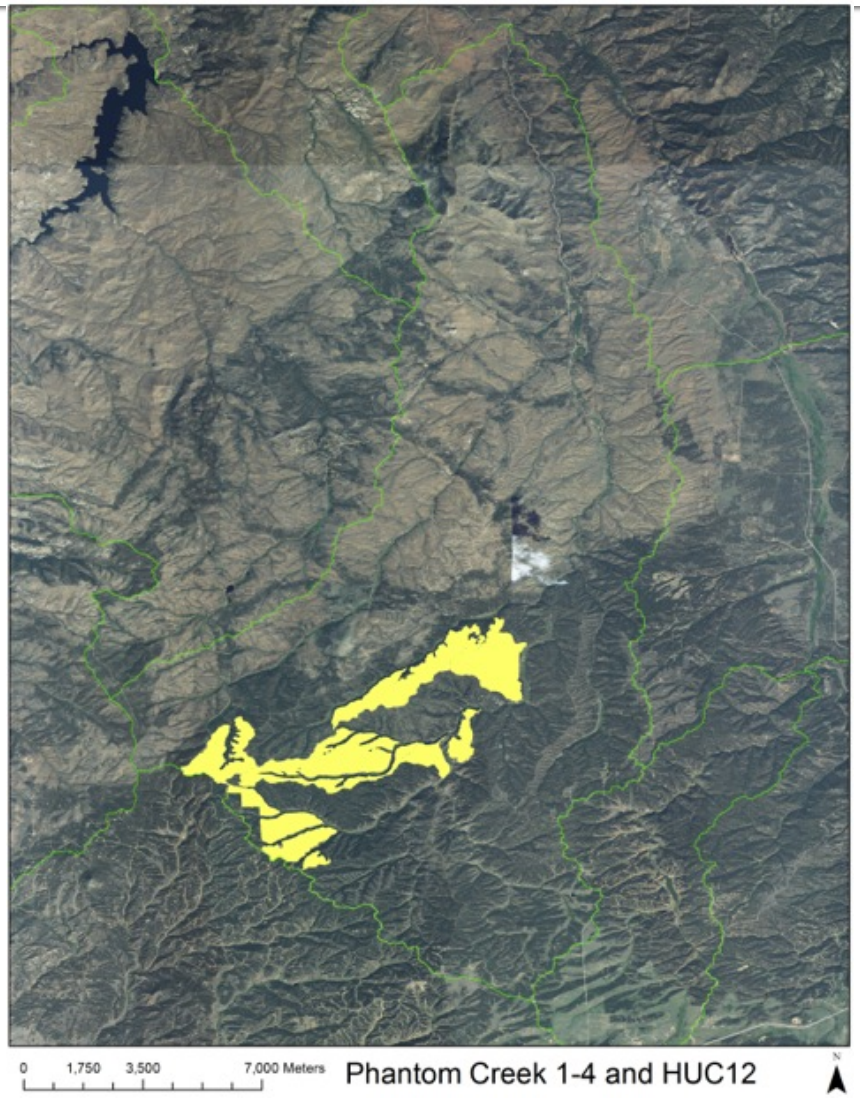
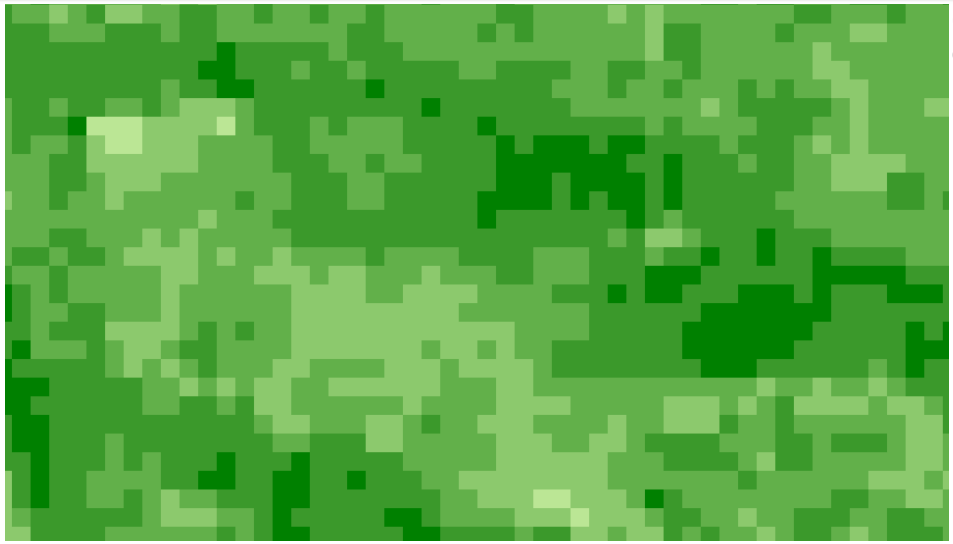


LANDFIRE data

- Free national dataset
- 30 x 30 m pixels
- Plan to refresh every 2 years
- Many variables describing vegetation type/structure, fuels, etc.
  - Some variables more reliable than others…
- Possible variables of interest:
  - Canopy cover
    - Cover by 10% increments in each 30 x 30 m pixel
    - Good accuracy
  - ? Species composition ?
    - Very questionable accuracy
    - But – may want to use it to define context in landscape



Questions and group discussion

- **Feedback on within-stand monitoring**
- Feedback about ideas for landscape-scale monitoring
- To keep in mind today: Where will this monitoring fit into ecological indicators?