Using LiDAR to Characterize Prescribed Fire and Thinning Disturbance

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About me

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- Monitoring Data Analyst, Lake County Resources Initiative/Lakeview Stewardship Group

Introduction

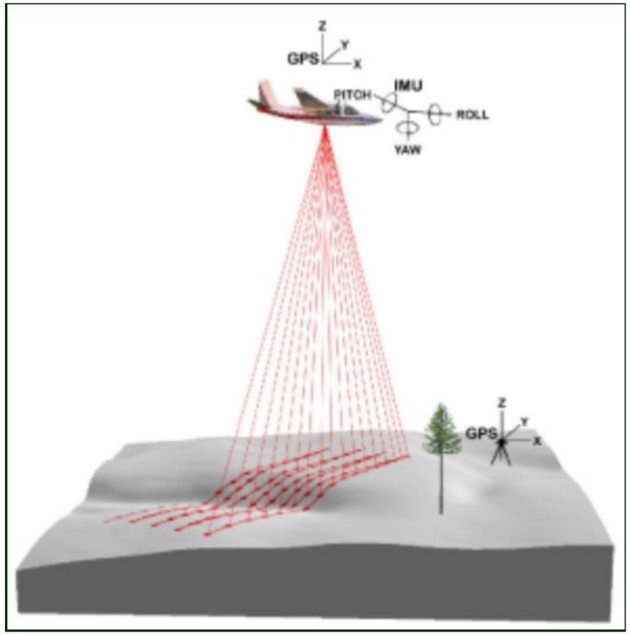
How do we know if treatments are effective in reducing fire risk?

CFLRP acreage	Target acreage
877,288	271,980

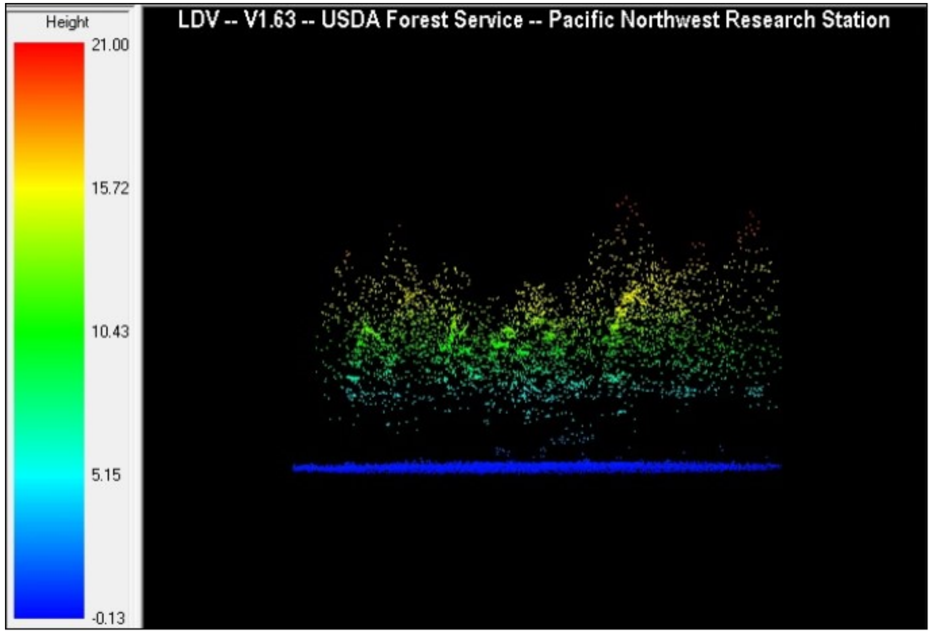
(Southern Blues 2011, 2017)

Introduction: Airborne LiDAR

"Light Detection and Ranging"



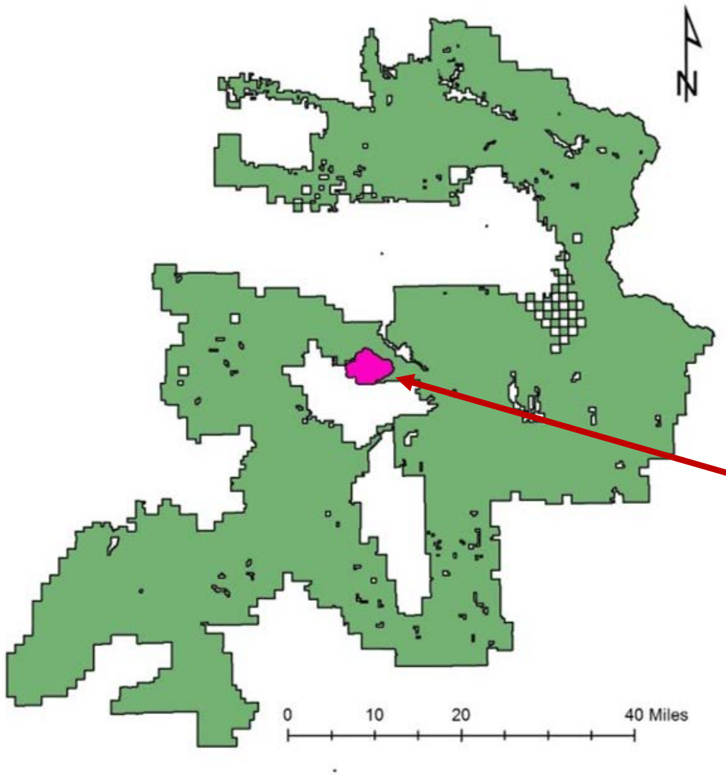
(Reutebuch *et al.*, 2005)

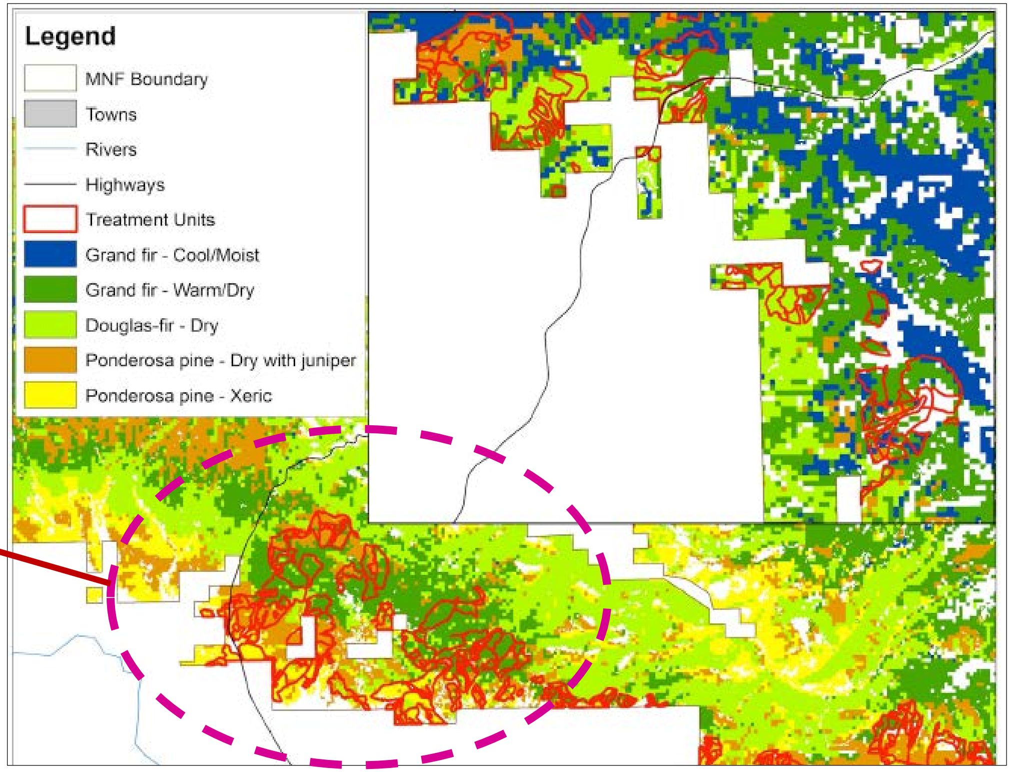


METHODS

Canopy Base Height and Ladder Fuel Hazard Assessment Class

Methods: Damon Project





Methods

1. Divide the study area by treatment combination and forest type
   - Mixed conifer, ponderosa pine
   - Burn, thin, thin/burn, no treatment

2. Collect field data on forest structure
   - Relate LiDAR data to field data
   - Use LiDAR data to predict forest structure throughout the study area

Methods: Treatment Combinations

Mixed conifer no treatment

Mixed conifer burn only

Methods: Treatment Combinations

Mixed conifer thin only

Mixed conifer thin/burn

Methods: Treatment Combinations

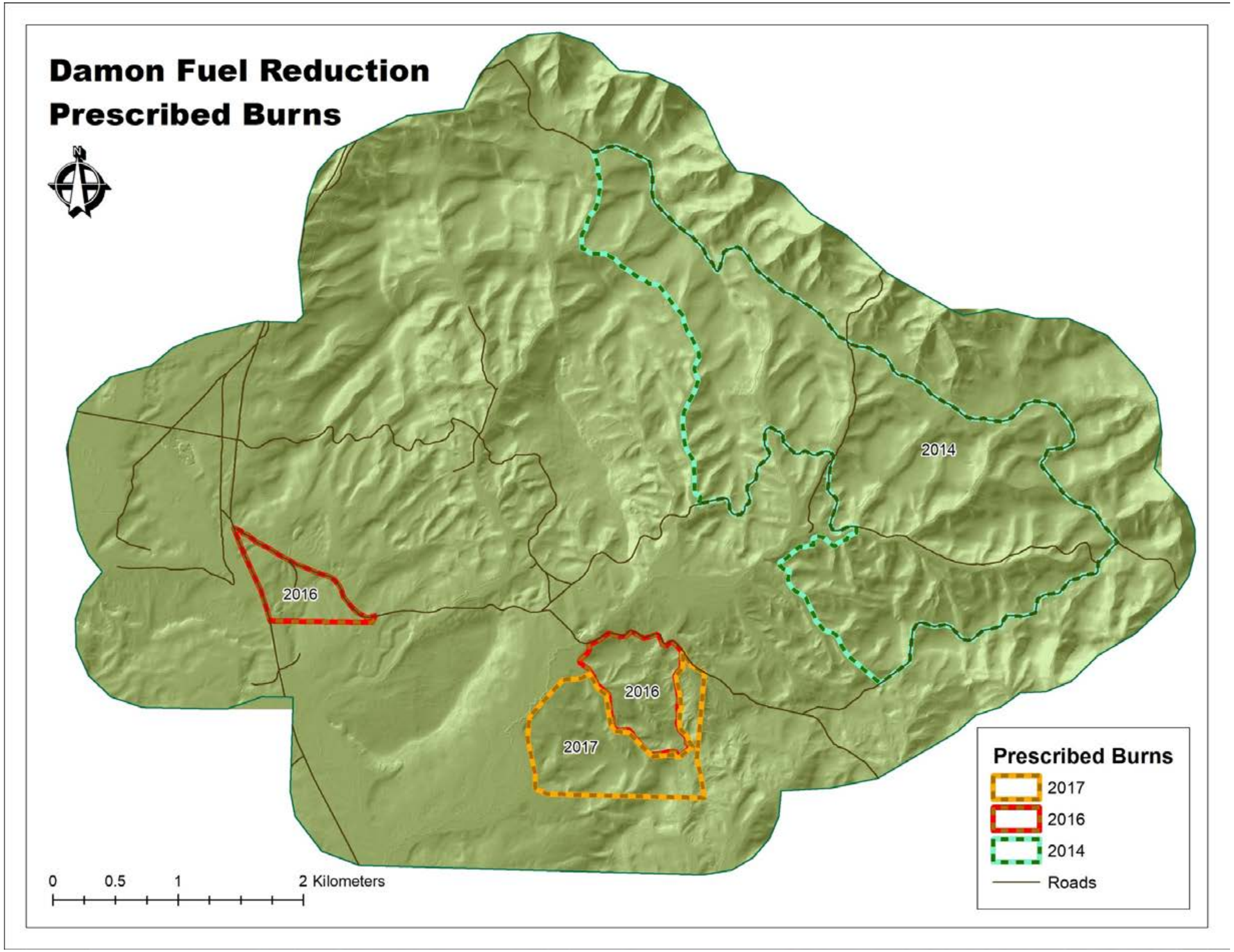
Ponderosa no treatment

Ponderosa burn only

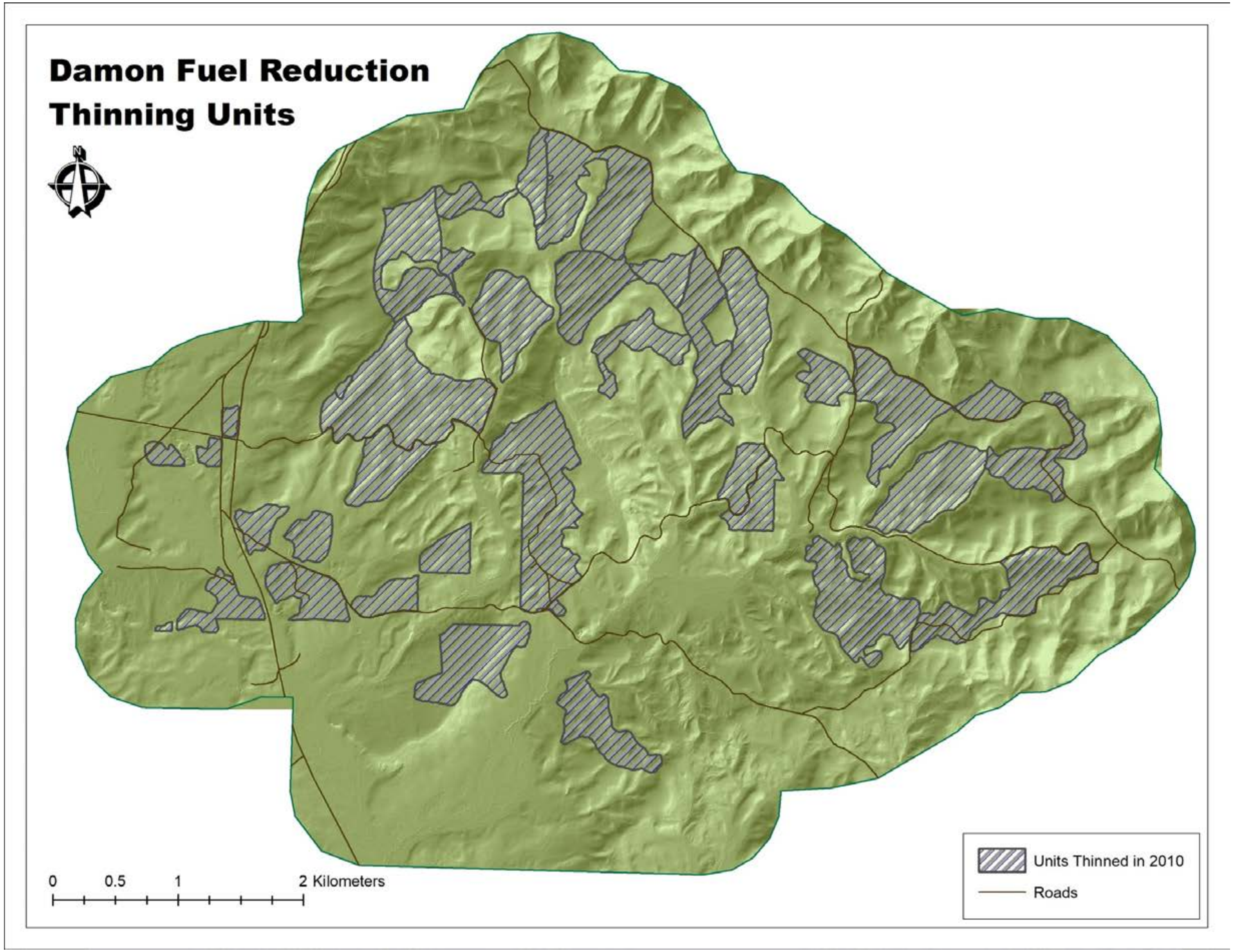
Methods: Treatment Combinations

Ponderosa thin only

Ponderosa thin/burn



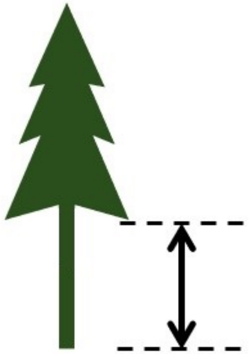
Damon Fuel Reduction
Prescribed Burns
N
2016
2016
2017
2014
0
0.5
1
2 Kilometers
Prescribed Burns
2017
2016
2014
Roads


Damon Fuel Reduction
Thinning Units
0
0.5
1
2 Kilometers
Units Thinned in 2010
Roads

Methods: Ladder Fuels

Canopy Base Height

- Quantitative metric
- Height from the ground to the base of the canopy
- Higher CBH = lower crown fire risk



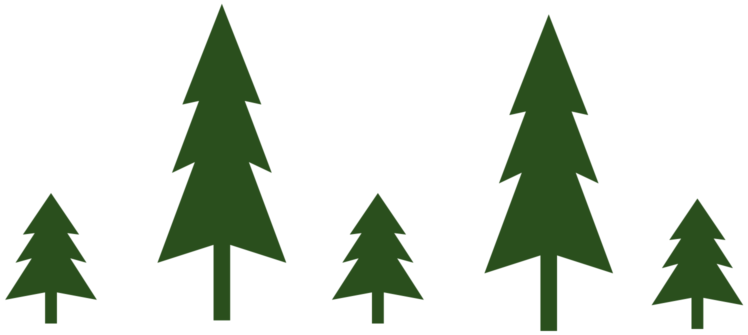
Ladder Fuel Hazard Assessment Class

- "LFHAC"
- Qualitative metric
- Classification based on presence of surface fuels and gaps between surface and canopy

Methods: Lifting CBH

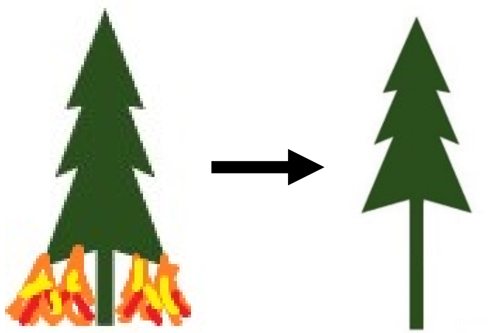
Indirect method

- Remove small trees



Direct method

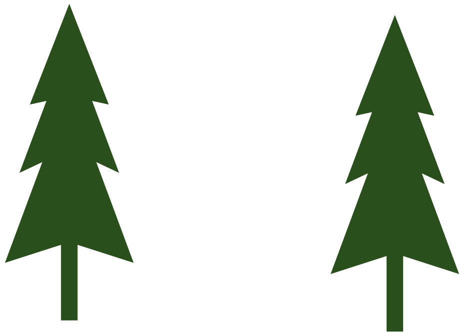
- Remove live and dead fuels from the base of the tree crowns in a stand



Methods: Lifting CBH

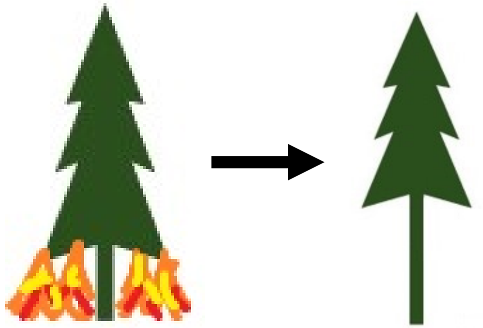
Indirect method

- Remove small trees



Direct method

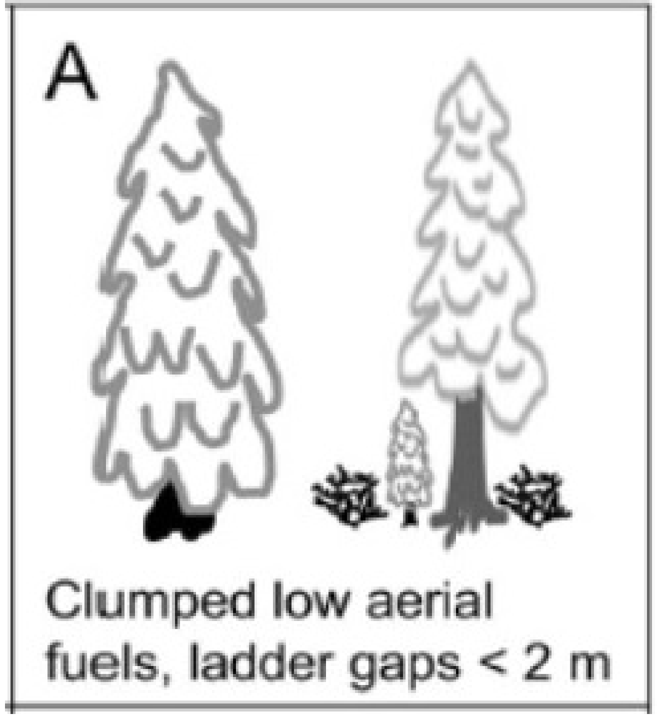
- Remove live and dead fuels from the base of the tree crowns in a stand



Methods

Canopy base height lift in progress…

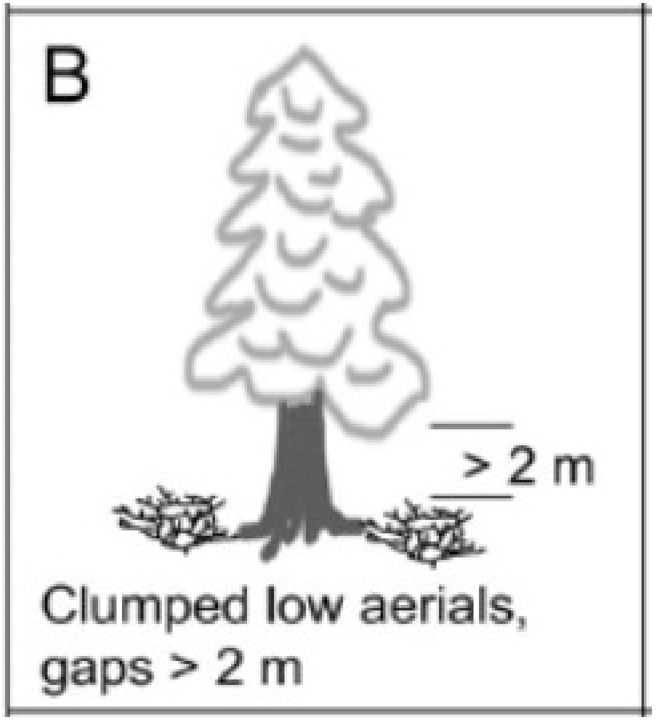
Methods: LFHAC



(Menning & Stephens, 2009)

Class A plot

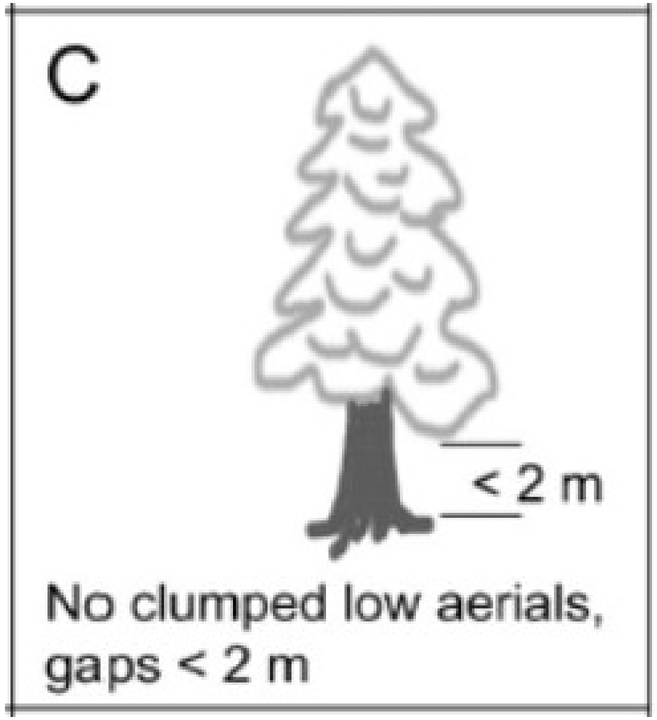
Methods: LFHAC



(Menning & Stephens, 2009)

Class B plot

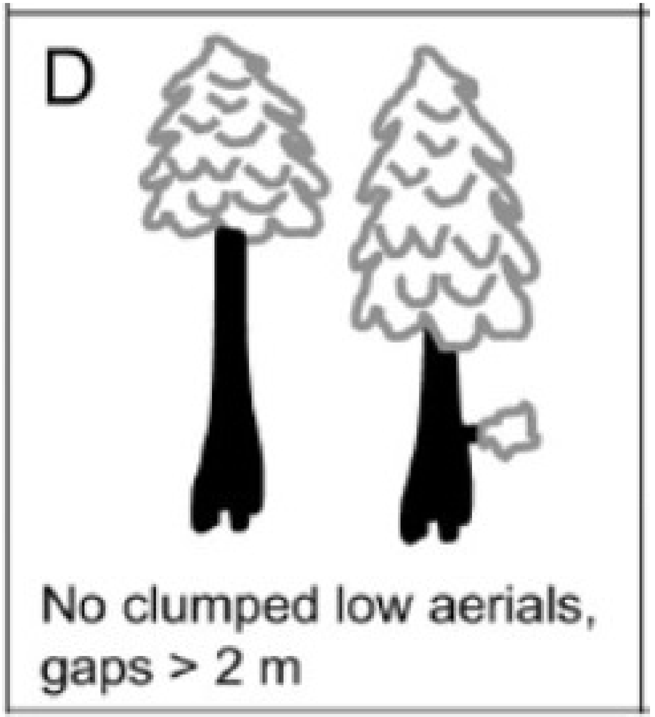
Methods: LFHAC



(Menning & Stephens, 2009)

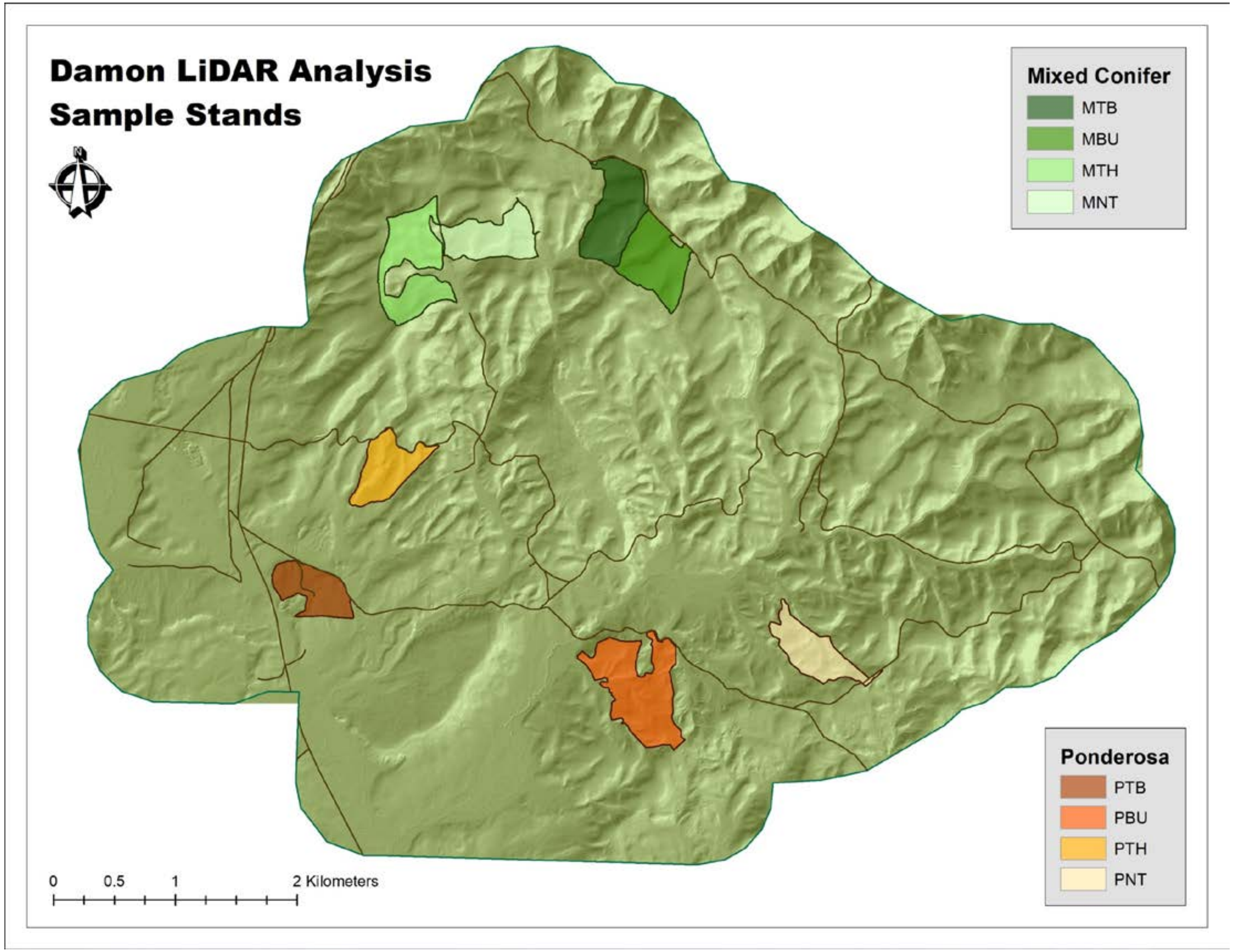
Class C plot

Methods: LFHAC



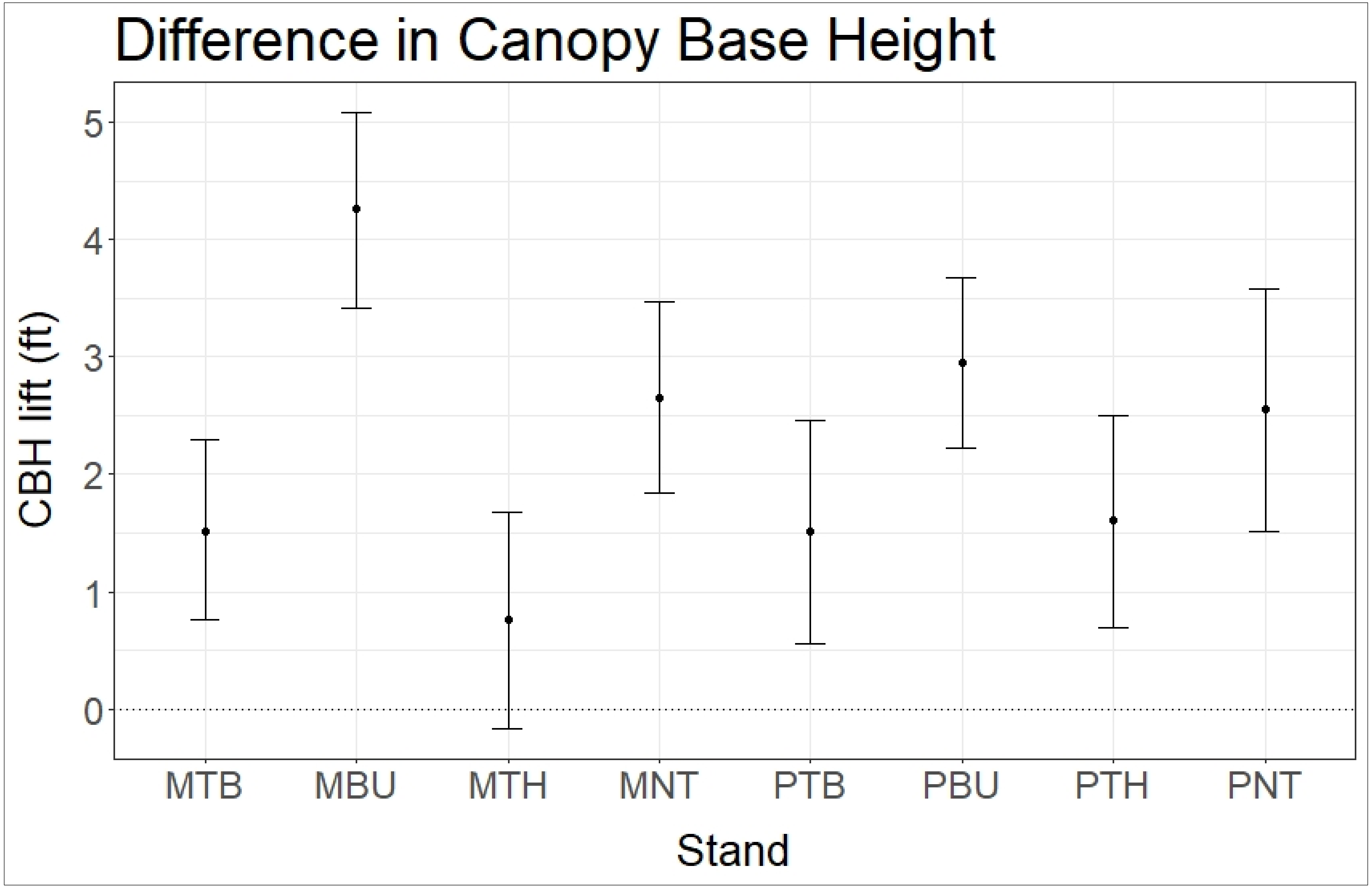
(Menning & Stephens, 2009)

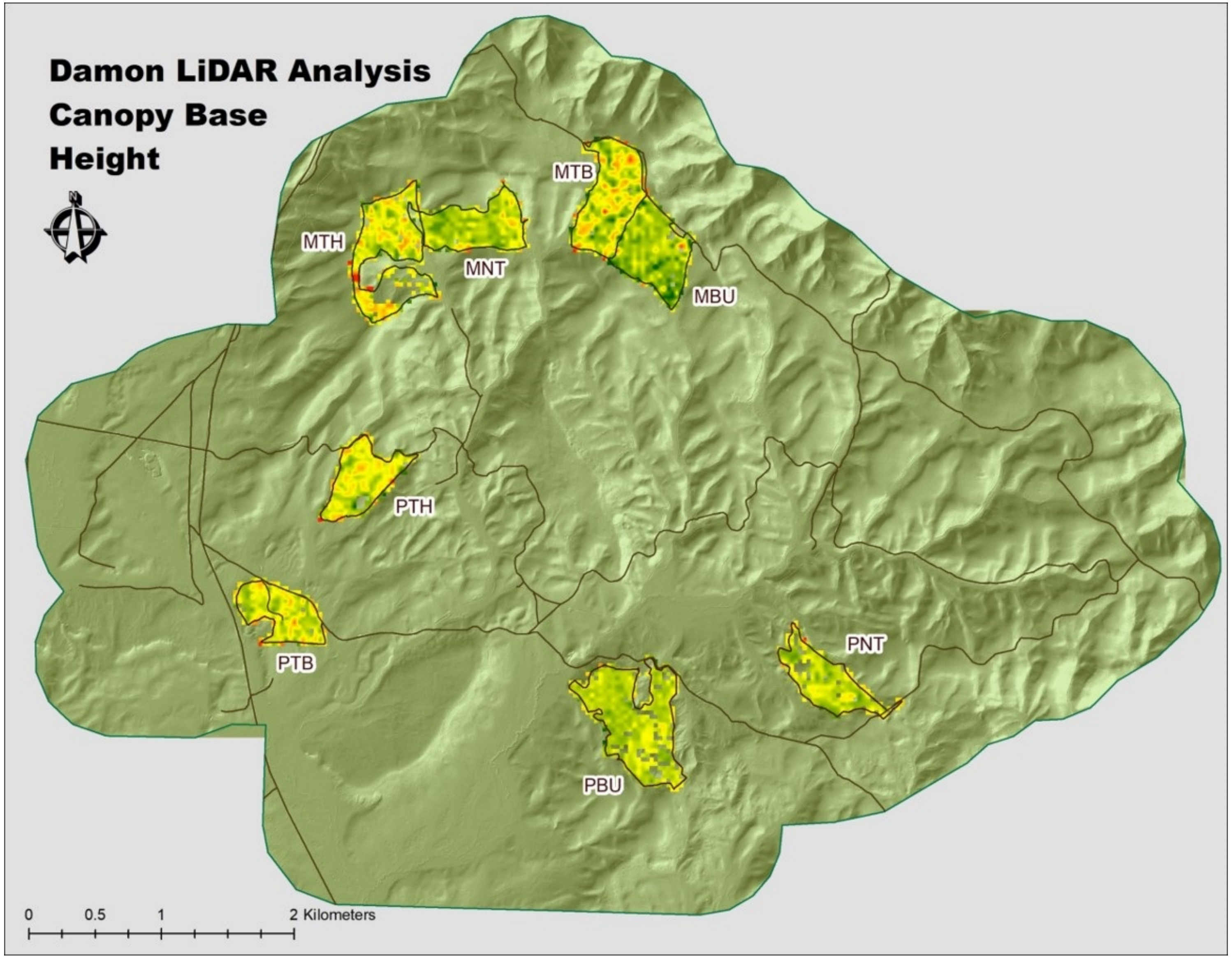
Class D plot

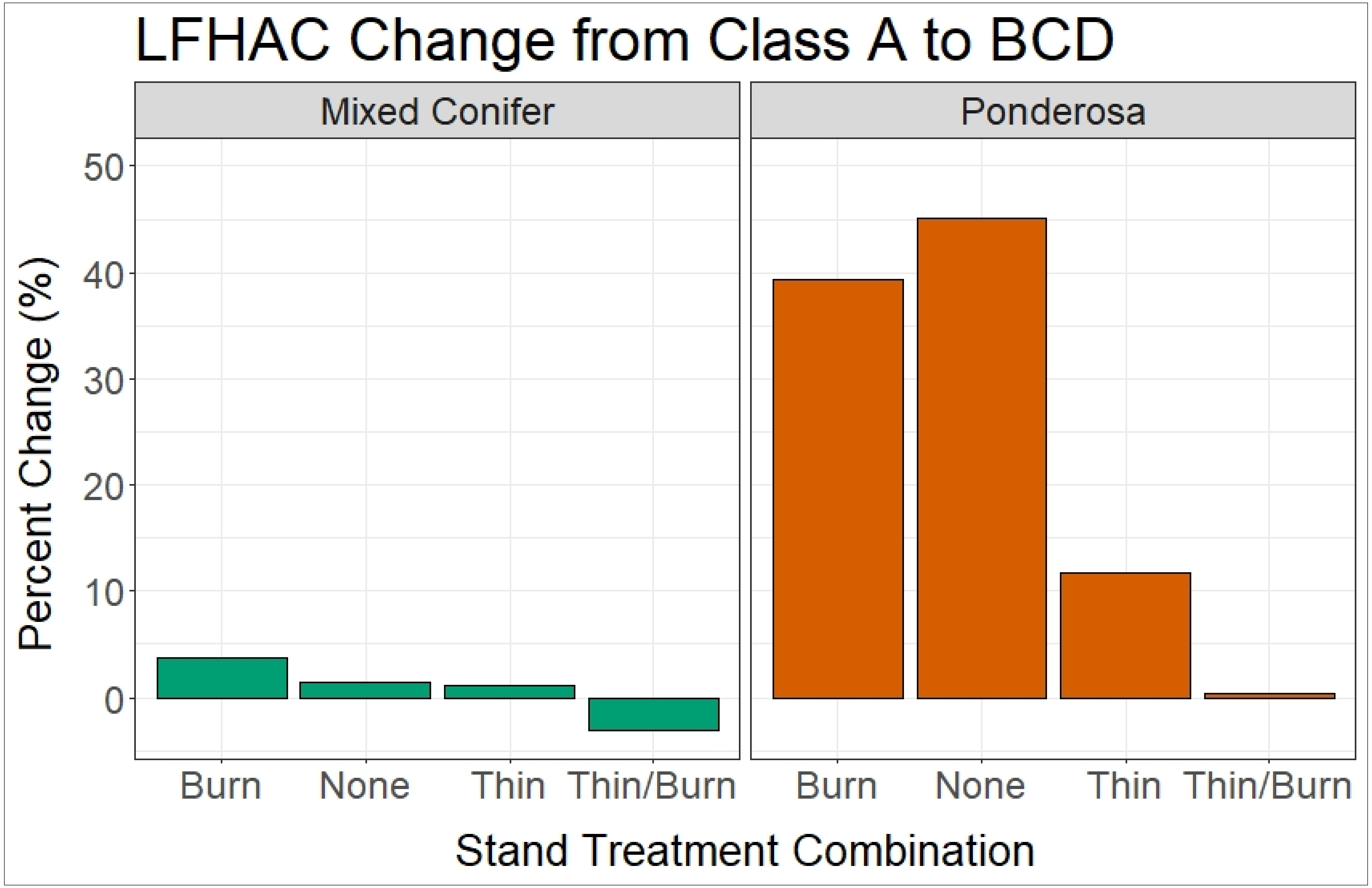

Damon LiDAR Analysis
Sample Stands
N
Mixed Conifer
MTB
MBU
MTH
MNT
Ponderosa
PTB
PBU
PTH
PNT
0
0.5
1
2 Kilometers

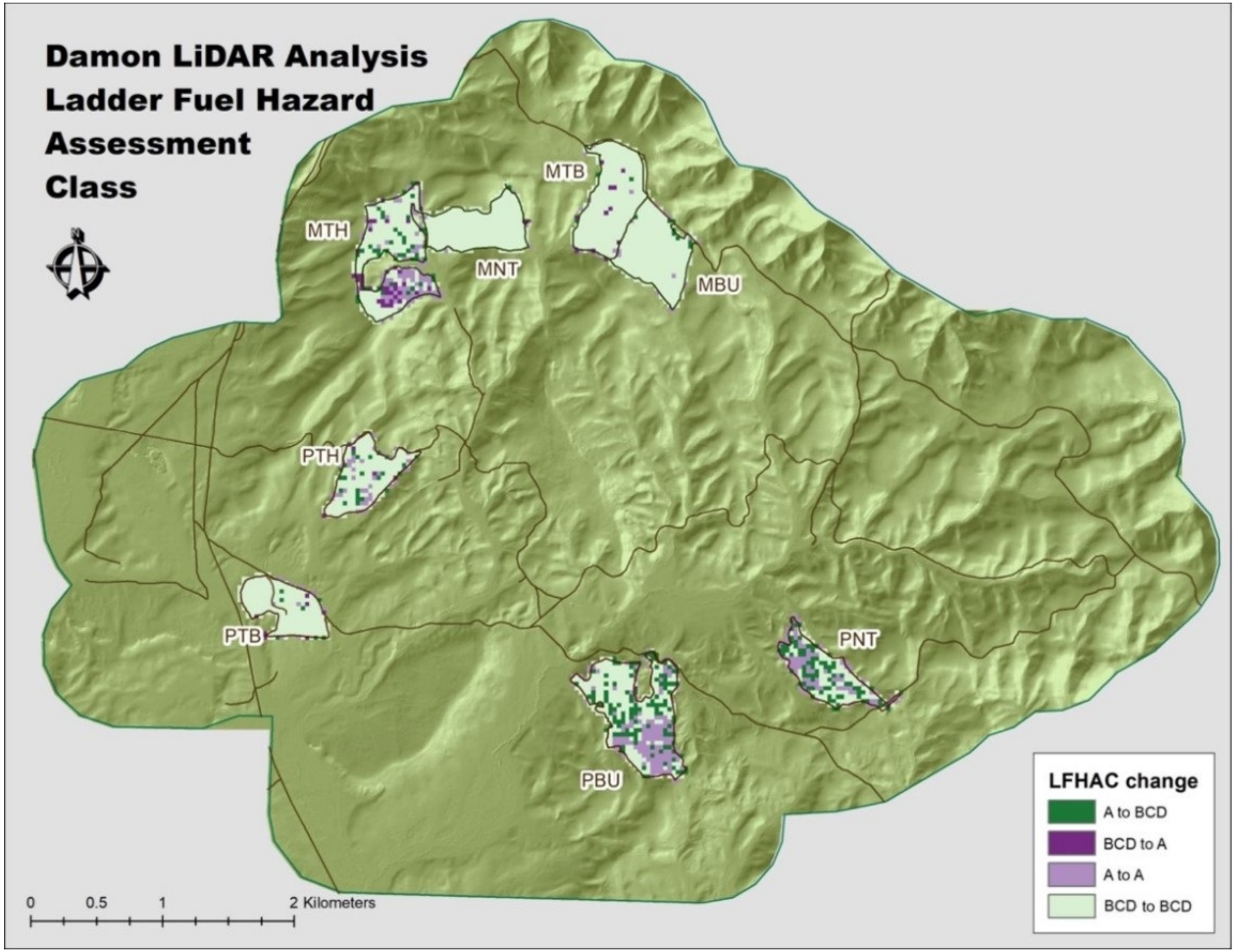
RESULTS

Canopy Base Height and Ladder Fuel Hazard Assessment Class


Difference in Canopy Base Height
CBH lift (ft)
0
1
2
3
4
5
Stand
MTB
MBU
MTH
MNT
PTB
PBU
PTH
PNT


Damon LiDAR Analysis
Canopy Base
Height
MTH
MNT
MTB
MBU
PTH
PTB
PBU
PNT
0
0.5
1
2 Kilometers


LFHAC Change from Class A to BCD
Mixed Conifer
Ponderosa
Percent Change (%)
50
40
30
20
10
0
Burn
None
Thin
Thin/Burn
Burn
None
Thin
Thin/Burn
Stand Treatment Combination


Damon LiDAR Analysis
Ladder Fuel Hazard
Assessment
Class
MTH
MNT
MTB
MBU
PTH
PTB
PBU
PNT
LFHAC change
A to BCD
BCD to A
A to A
BCD to BCD
0
0.5
1
2 Kilometers

CONCLUSIONS

Final Thoughts and Future Directions

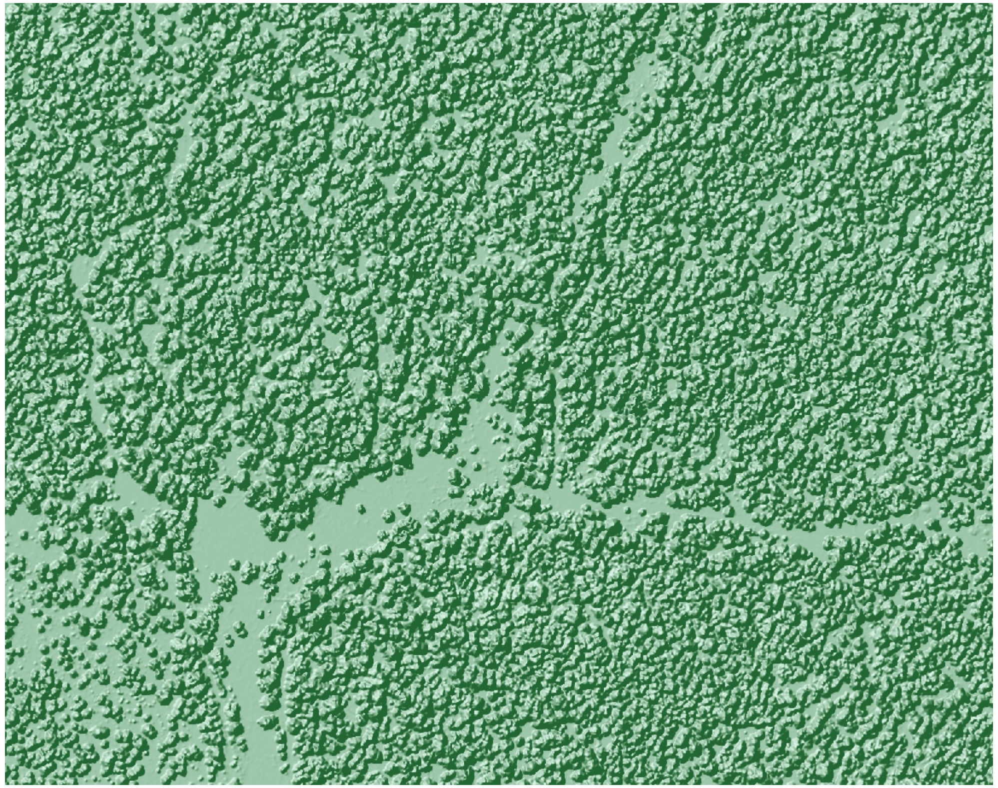
Conclusions

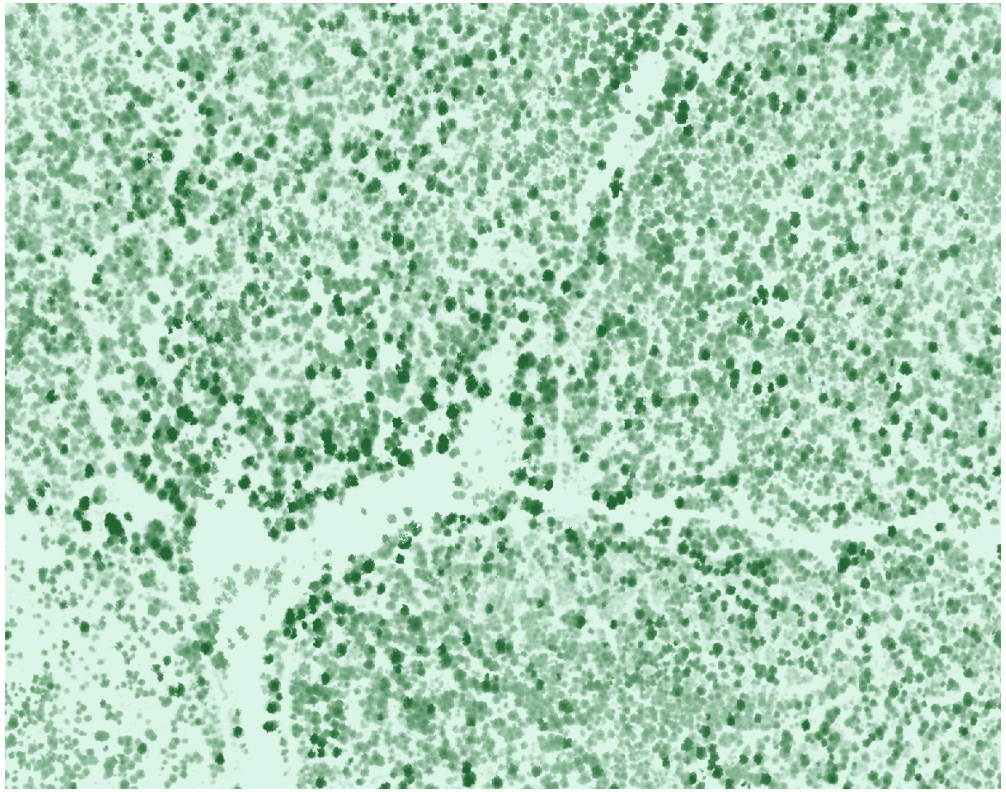
- Can LiDAR be used to evaluate hazard fuel reduction treatments?
  - Yes

- Keep in mind:
  - No horizontal fuel continuity
  - Factors other than vertical fuel continuity

Conclusions

- Other uses for LiDAR: horizontal spatial analysis





References

Kramer, H., Collins, B., Kelly, M., & Stephens, S. (2014). Quantifying Ladder Fuels: A New Approach Using LiDAR. *Forests*, *5*(6), 1432–1453.

Menning, K. M., & Stephens, S. L. (2007). Fire Climbing in the Forest: A Semiqualitative, Semiquantitative Approach to Assessing Ladder Fuel Hazards. *Western Journal of Applied Forestry*, *22*(2), 88–93.

Reutebuch, S. E., Andersen, H.-E., & McGaughey, R. J. (2005). Light Detection and Ranging (LIDAR): An Emerging Tool for Multiple Resource Inventory. *Journal of Forestry*, *103*(6), 286–292.

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Southern Blues Restoration Coalition. (2017). CFLRP Annual Report: 2017 [Web]. https://www.fs.fed.us/restoration/documents/cflrp/2017AnnualReports/Southern_Blues_Restoration_Coalition_FY17.pdf

QUESTIONS?

BONUS SLIDES

LiDAR Acquisition

2007

- Leica ALS50 Phase II laser instrument, Cessna Caravan 208B, Watershed Sciences Inc. of Corvallis, OR.
- Acquisition dates: September 15th and 16th.
- Scan angle: +/- 14⁰ from nadir (Watershed Sciences 2007).

2017

- Leica ALS 80 laser instrument, Cessna Grand Caravan, Quantum Spatial of Portland, OR.
- Acquisition dates: June 14th to July 9th.
- Field of view: 30⁰ (Quantum Spatial 2017).

Watershed Sciences merged with two other companies in 2013 to form Quantum Spatial (PRWeb 2013).

Relative Accuracy	2007	2017
Project Mean	0.066 m	0.045 m
Median Relative Accuracy	0.067 m	0.045 m
1 sigma Relative Accuracy	0.070 m	0.051 m
2 sigma Relative Accuracy	0.079 m	0.071 m

Density	2007	2017
Avg pulse density (per m^2)	6.31	11.80
Avg ground density (per m^2)		1.99
Projection	UTM Zone 11 North	UTM (2011) Zone 11 North
Horizontal Datum	NAD83	NAD83
Vertical Datum	NAVD88 Geoid03	Geoid 12B
Units	Meters	Meters/Feet

Absolute/ Vertical Accuracy	2007	2017 NV	2017 Veg
Sample size (n)	1007	61	45
Vert accuracy at 95% conf level (RMSE*1.96)	0.024 m	0.074 m	0.251 m
RMSE	0.025 m	0.038 m	0.103 m
1 SD	0.024 m	0.035 m	0.099 m
2 SD	0.050 m		
Minimum deviation	-0.064 m	-0.078 m	-0.119 m
Maximum deviation	0.08 m	0.085 m	0.334 m
Average deviation	-0.018 m		

LiDAR Variables

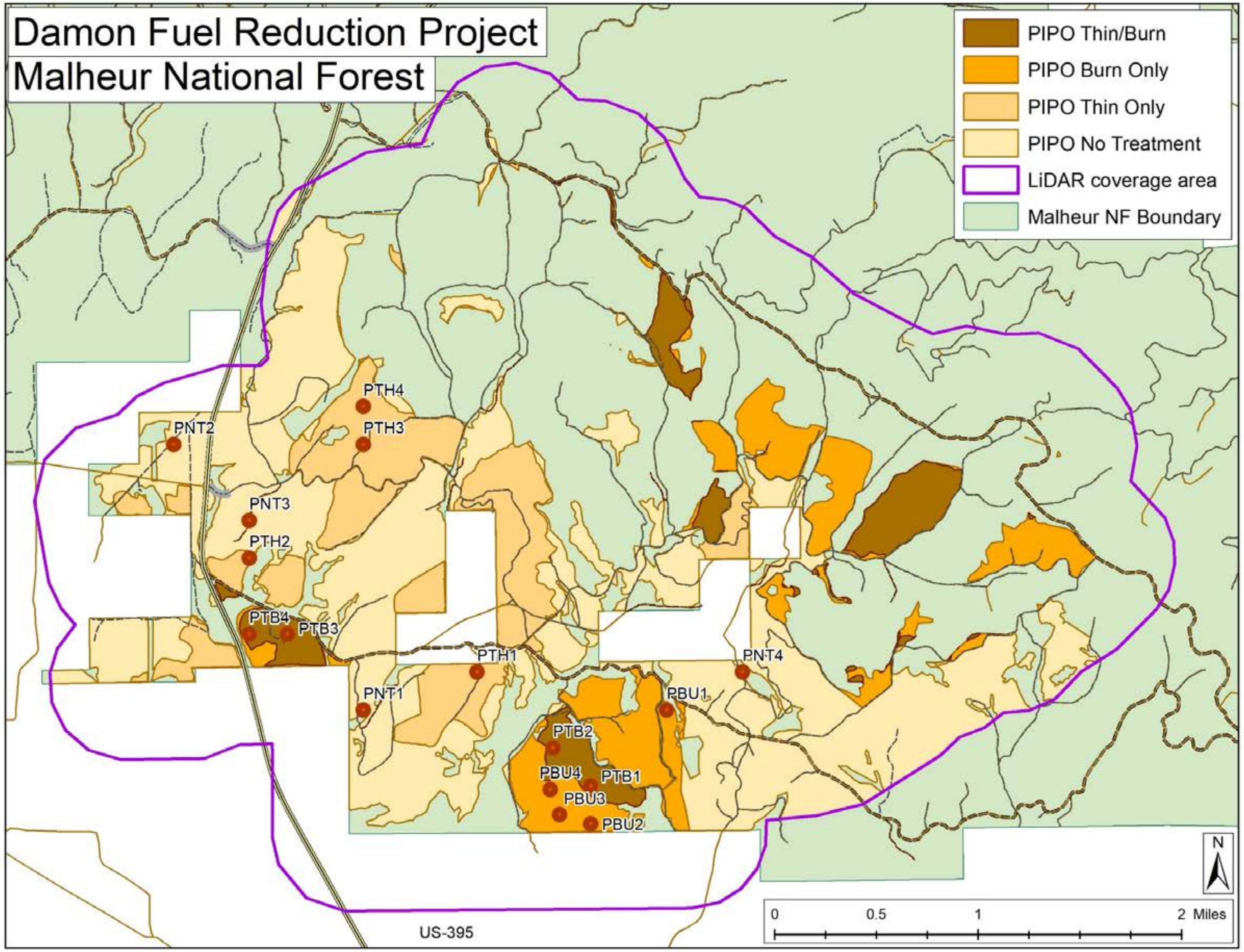
LiDAR Metric	LiDAR Metric Description
Elev_max	Maximum return elevation
Elev_mean	Mean return elevation
Elev_mode	Mode return elevation
Elev_stddev	Standard deviation return elevations
Elev_variance	Variance of return elevations
Elev_CV	Coefficient of variation of return elevations
Elev_skewness	Skewness of return elevations
Elev_kurtosis	Kurtosis of return elevations
Elev_P01	1st percentile return elevation
Elev_P05	5th percentile return elevation
Elev_P10	10th percentile return elevation
Elev_P20	20th percentile return elevation
Elev_P25	25th percentile return elevation
Elev_P30	30th percentile return elevation
Elev_P40	40th percentile return elevation
Elev_P50	50th percentile return elevation

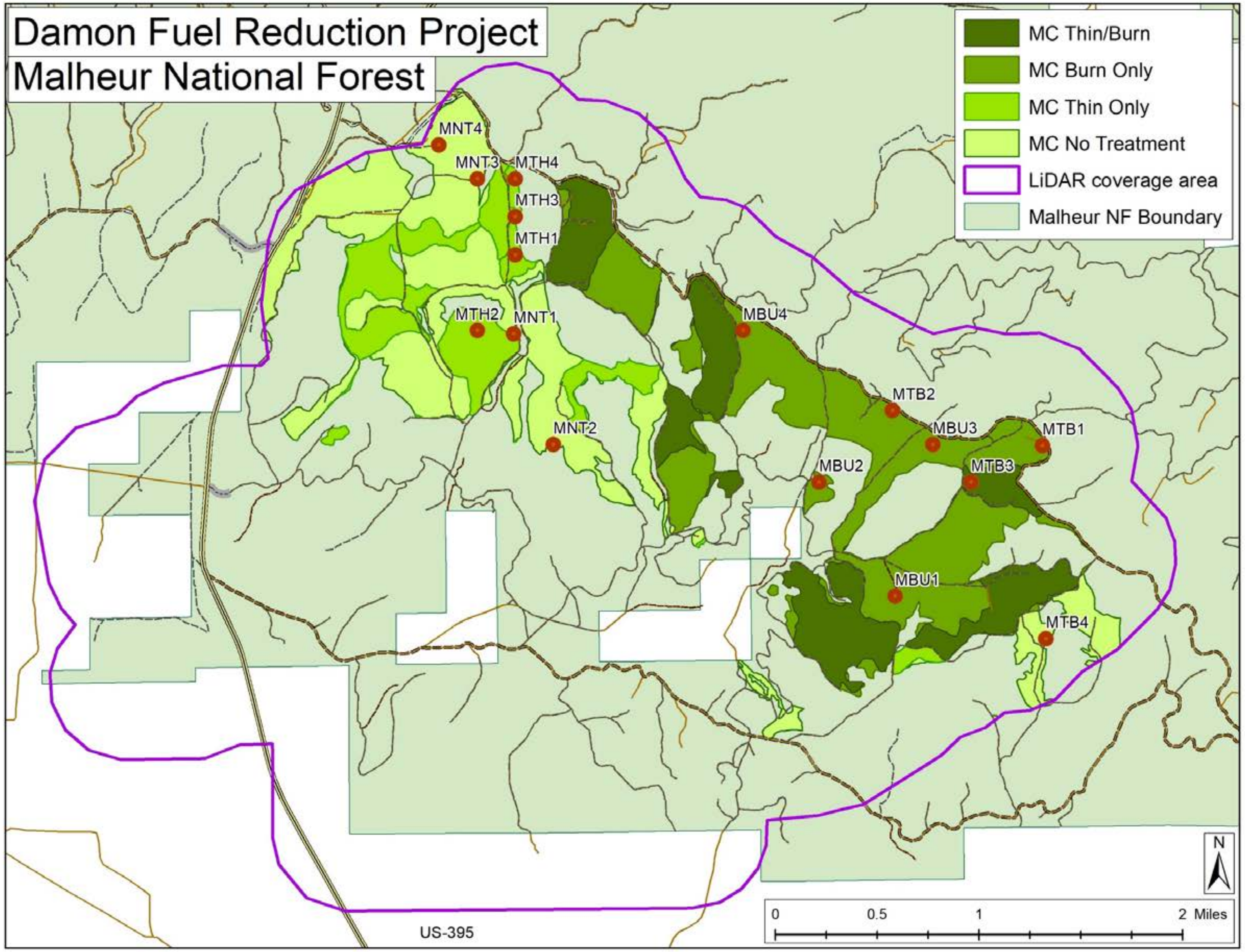
LiDAR Metric	LiDAR Metric Description
Elev_P60	60th percentile return elevation
Elev_P70	70th percentile return elevation
Elev_P75	75th percentile return elevation
Elev_P80	80th percentile return elevation
Elev_P90	90th percentile return elevation
Elev_P95	95th percentile return elevation
Elev_P99	99th percentile return elevation
Elev_2_ret_prop	Proportion of returns below 2 meters
Elev_2_4_ret_prop	Proportion of returns between 2 meters and 4 meters
Elev_4_6_ret_prop	Proportion of returns between 4 meters and 6 meters
Elev_6_8_ret_prop	Proportion of returns between 6 meters and 8 meters
u4_prop	Proportion of returns below 4 meters
u6_prop	Proportion of returns below 6 meters
u8_prop	Proportion of returns below 8 meters
prop_2_6	Proportion of returns between 2 meters and 6 meters
prop_2_8	Proportion of returns between 2 meters and 8 meters
prop_4_8	Proportion of returns between 4 meters and 6 meters

Hazard Fuel Reduction: Before and After

Monitoring plot, pre-treatment

Monitoring plot, post-treatment


Damon Fuel Reduction Project
Malheur National Forest
PIPO Thin/Burn
PIPO Burn Only
PIPO Thin Only
PIPO No Treatment
LiDAR coverage area
Malheur NF Boundary
PTH4
PTH3
PNT2
PNT3
PTH2
PTB4
PTB3
PTH1
PNT1
PNT4
PBU1
PTB2
PBU4
PTB1
PBU3
PBU2
N
0
0.5
1
2 Miles
US-395


Damon Fuel Reduction Project
Malheur National Forest
MC Thin/Burn
MC Burn Only
MC Thin Only
MC No Treatment
LiDAR coverage area
Malheur NF Boundary
MNT4
MNT3
MTH4
MTH3
MTH1
MTH2
MNT1
MNT2
MBU4
MTB2
MBU3
MTB1
MBU2
MTB3
MBU1
MTB4
N
0
0.5
1
2 Miles
US-395