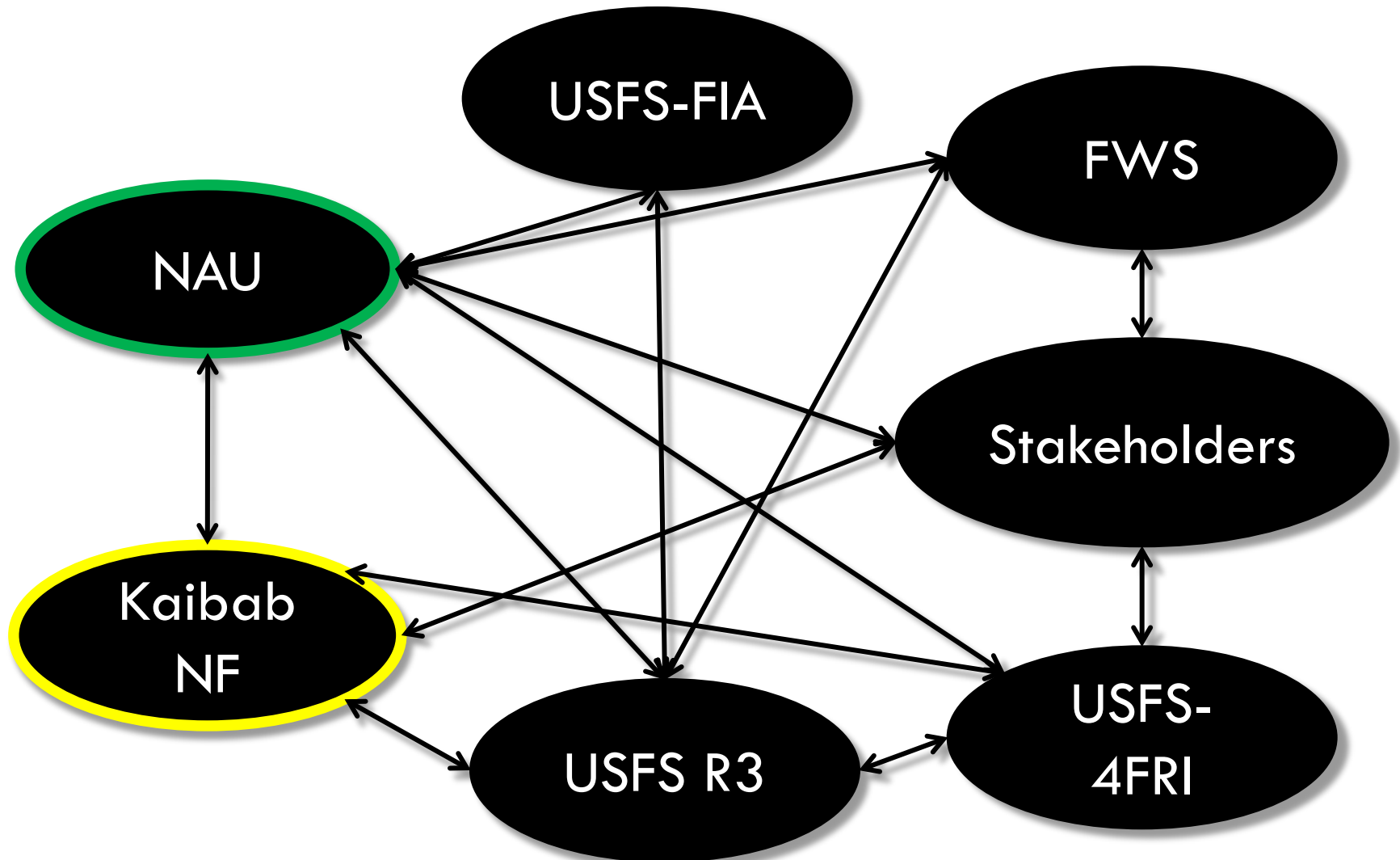2006

2010

Tornado

Thin

LANDSCAPE SCALE MONITORING OF FOREST TREATMENTS AND DISTURBANCE

S.E. Sesnie[1,2], A.D. Olsson[1], B.G. Dickson[1], A. Leonard[3], V. Stein Foster[3] and C. Ray[1]

Lab of Landscape Ecology and Conservation Biology, NAU[1], US Fish & Wildlife Service[2], USFS Kaibab NF[3]

Collaborative Partnerships

Previous assessments

Statewide Strategy for Restoring Arizona's Forests

The Kaibab Forest Health Focus

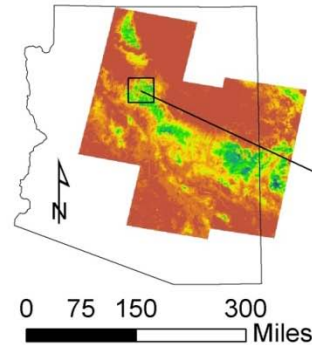Collaborative Prioritization of Landscapes and Restoration Treatments on the Kaibab National Forest

Final Report
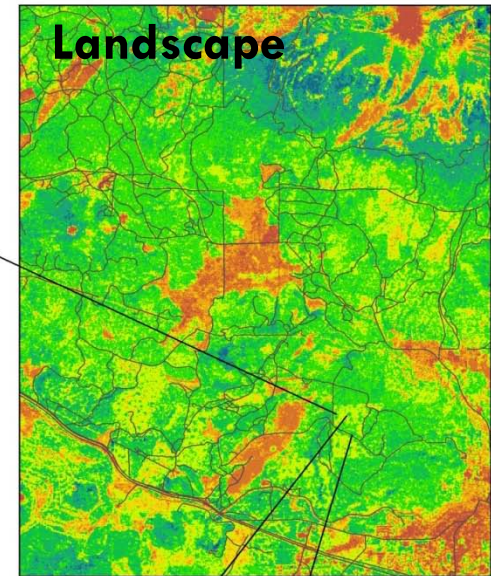
Analysis of Small-Diameter Wood Supply in Northern Arizona

May 2007– February 2008

Region

Landscape
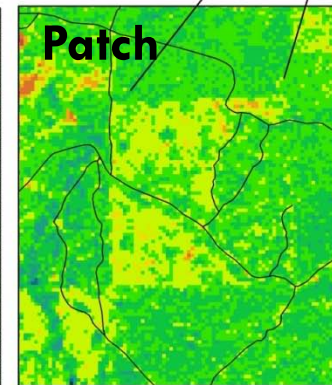
Aerial photograph of restoration treatment near Flagstaff, AZ

Patch

Volume (ft^3/ac)
- 0 - 151
- 152 - 491
- 492 - 915
- 916 - 1,396
- 1,397 - 1,905
- 1,906 - 2,414
- 2,415 - 2,980
- 2,981 - 3,829
- 3,830 - 5,073
- 5,074 - 7,195
- Roads

Disturbance

Fire

Urbanization

Insects & Disease

Silviculture

Wind

Drought

Kaibab NF Monitoring

Need for <u>landscape-scale</u>, <u>up-to-date</u> and <u>repeatable</u> forest data complementary to:

❑ Monitoring planned and unplanned disturbance

❑ Assessing changes wildlife habitat

❑ Mitigating fire hazard and risk

- -

❑ Biomass & forest carbon assessment

❑ Other planning objectives
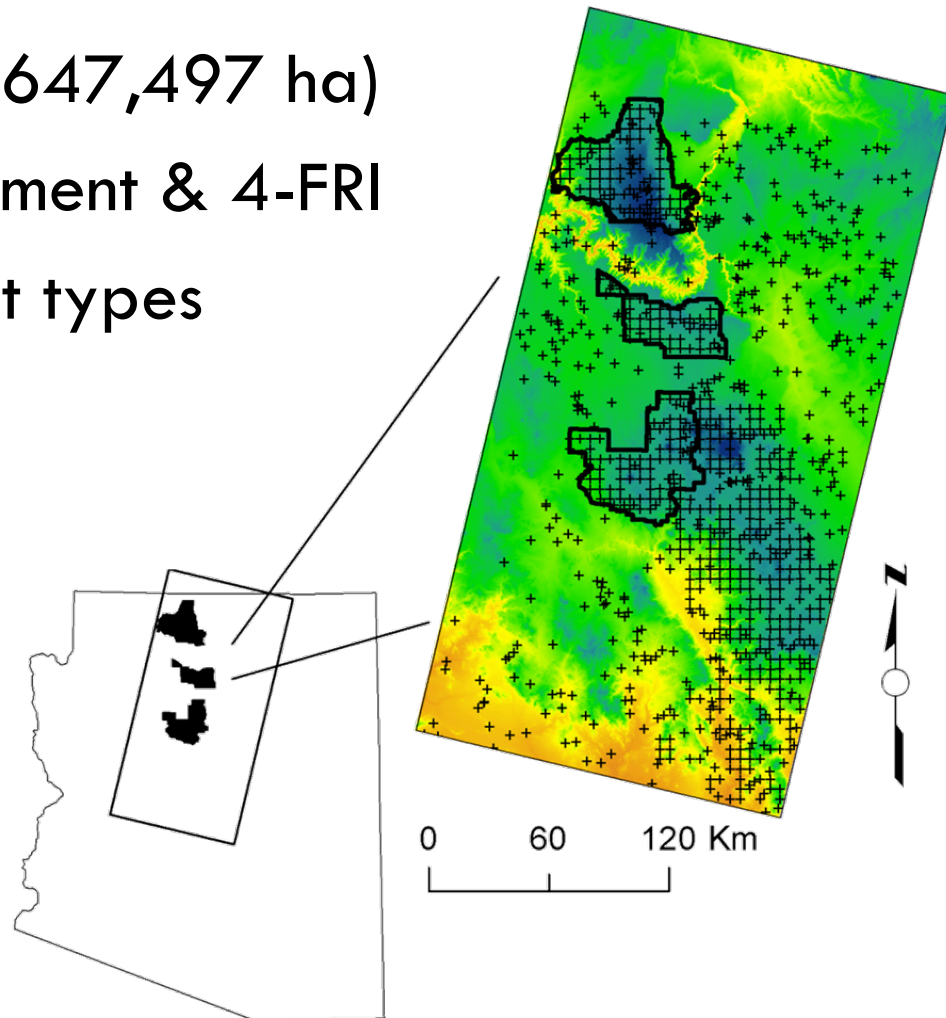
Objectives

Model & map forest structure

❑ Inexpensive

❑ Validated

❑ Consistent/repeatable

BA
SDI
HGT
CC
TPA
QMD
Others…
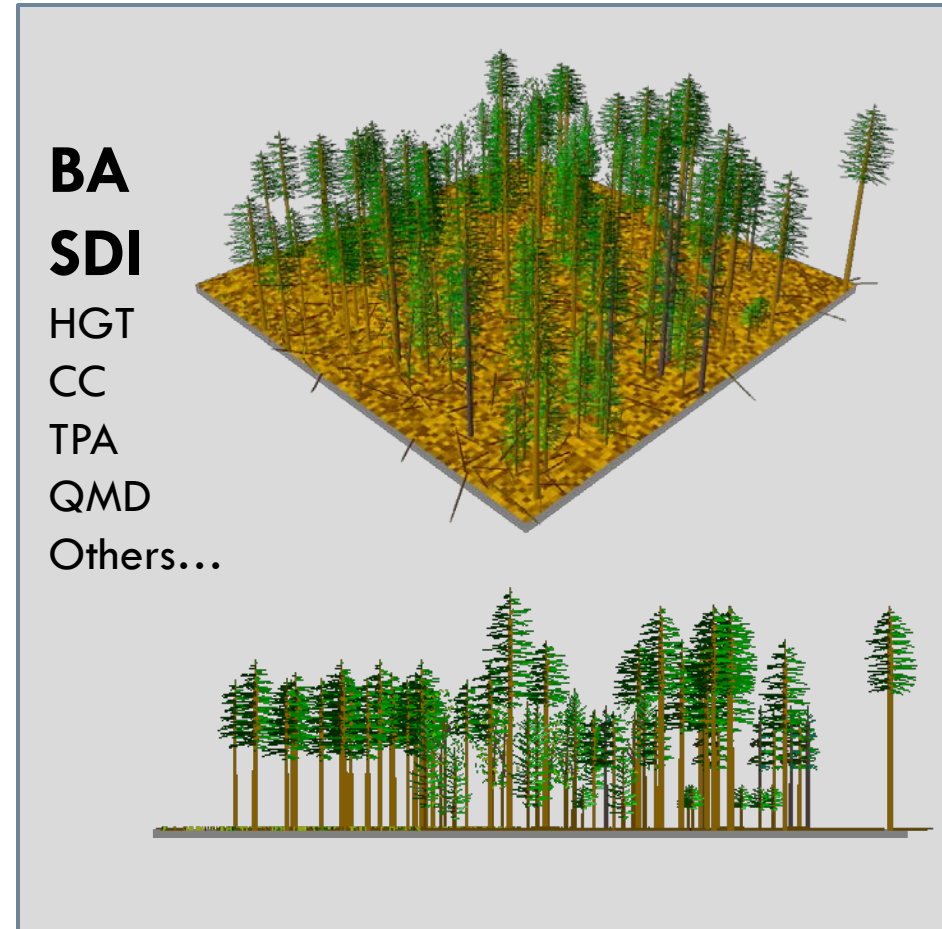
Study Area – Kaibab NF

- 1.6 million acres (647,497 ha)
- Ongoing management & 4-FRI
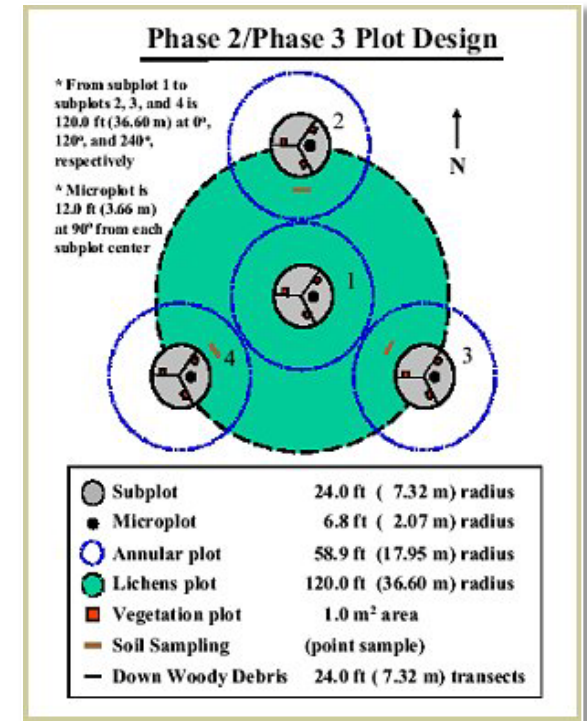- Three major forest types

0   60   120 Km

Methods – reference data

USFS Forest Inventory and Analysis (FIA) plots

- ❑ Measure10% of state's forest per year

- ❑ n = 648 plots (2001 – 2009)

- ❑ Monitor forest status and trends

- ❑ FVS compatible

~1 acre of forest land

Methods – remotely sensed data

Landsat TM (2006 & 2010)
- 6 spectral bands
- 2 dates (leaf on/off)

Spectral Derivatives
- NDVI
- NDVIc

Digital Elevation Model
- Elevation
- Terrain

39 Predictor Variables

Leaf-on	**Leaf-off**
TM1	TM1
TM2	TM2
TM3	TM3
TM4	TM4
TM5	TM5
TM7	TM7
Brightness	Brightness
Greenness	Greenness
Wetness	Wetness
NDVI_on	NDVI_off
NDVIc_on	NDVIc_off
NDVI4_on	NDVI4_off
PCA1	PCA1
PCA2	PCA2
PCA3	PCA3

DEM
Elevation
Slope
Aspect (trasp)
Roughness
CTI

Others
NDVI_ratio

Methods – correction + modeling

Image correction:

- ◻ Uncorrected Landsat TM

- ◻ Image normalization (MAD)

- ◻ Atmospheric correction (FLAASH)

- ◻ Terrain correction (C-correction)

Modeling:

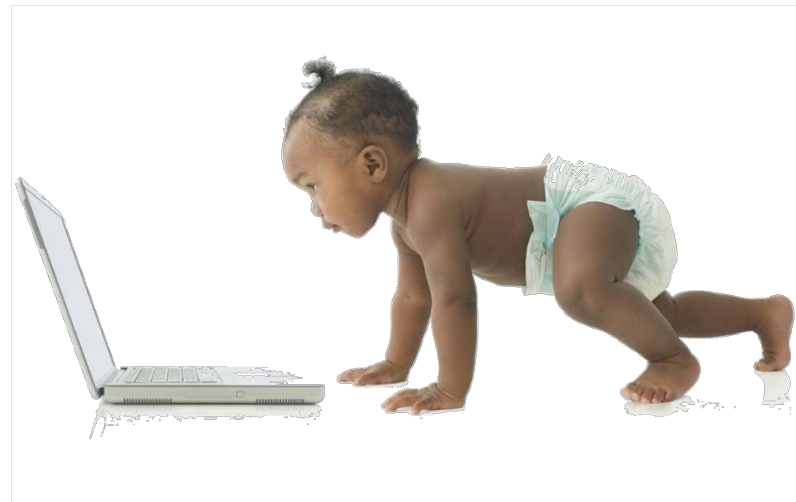- ◻ Random Forest (regression)

Literature & Tools

Click to **LOOK INSIDE!**

SECOND EDITION

IMAGE ANALYSIS, CLASSIFICATION, and CHANGE DETECTION in REMOTE SENSING

With Algorithms for ENVI/IDL

Morton J. Canty

kindle edition
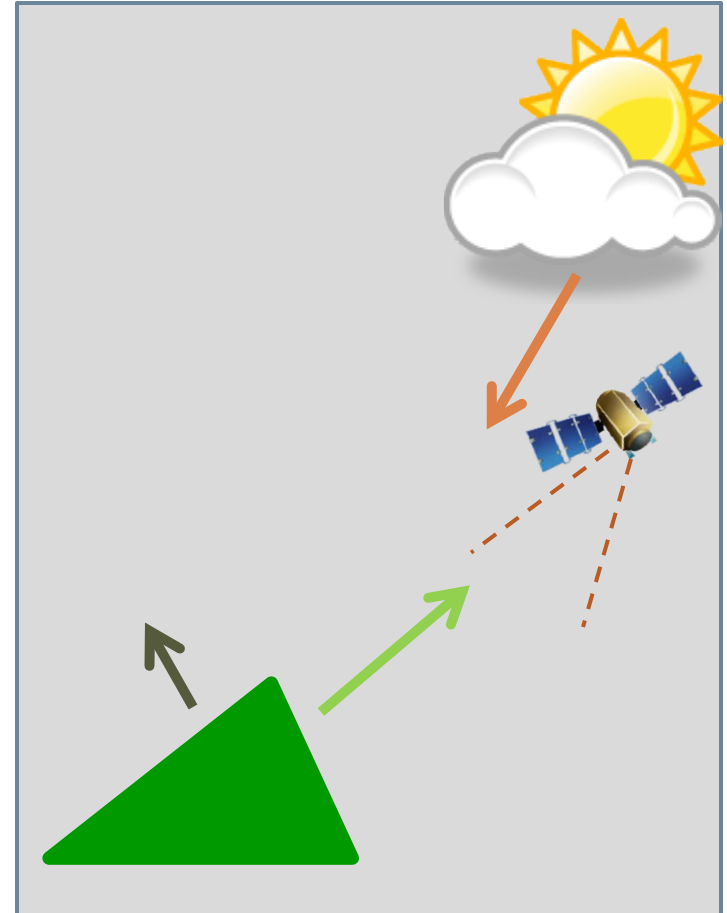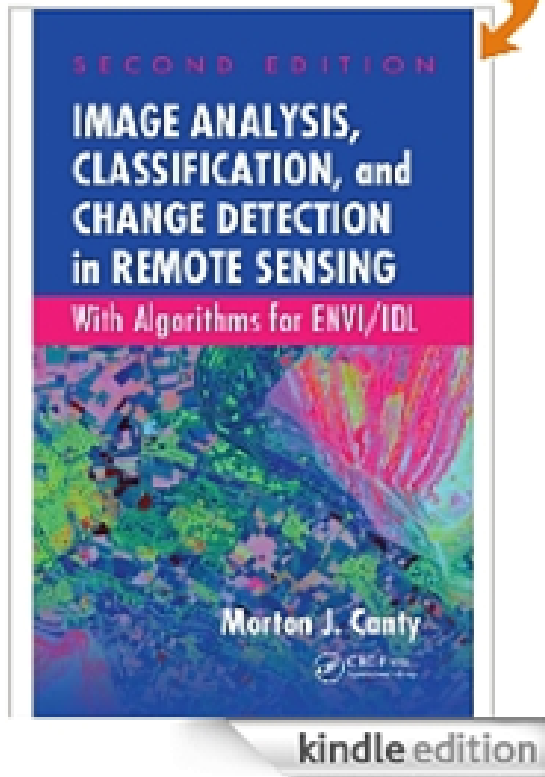
Multispectral Image Analysis

File	Spectral	Spatial	Change	Help
Upload ▾ Go	PCA ▾ Go	Fourier ▾ Go	IR-MAD ▾ Go	Overview ▾ Go

powered by **Google** App Engine

Results – outputs
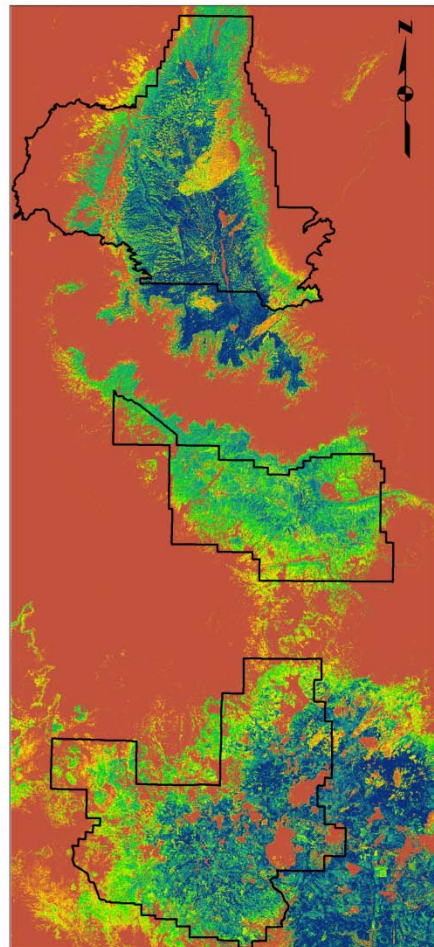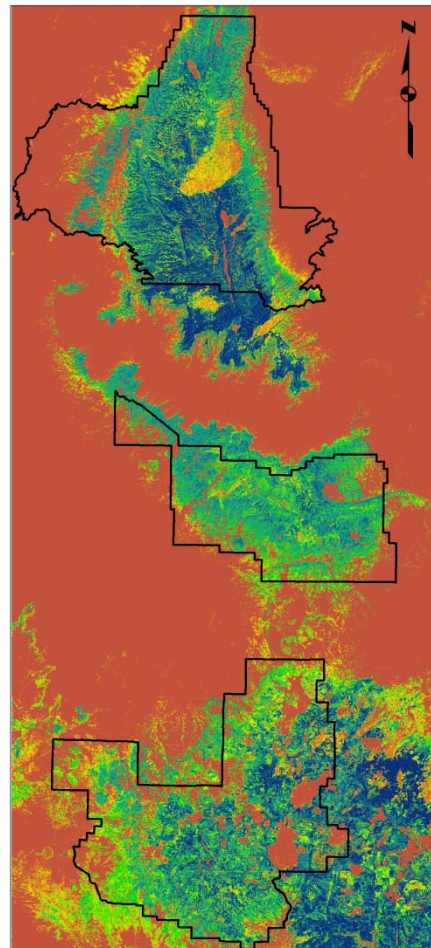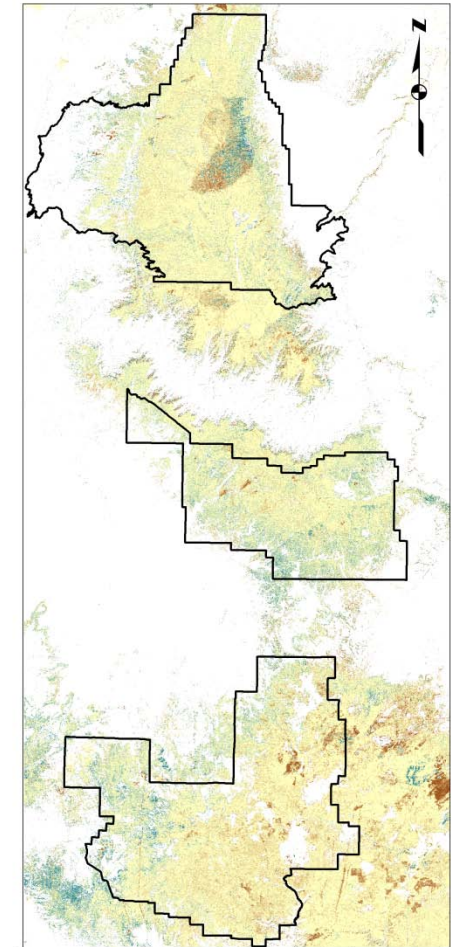
2006

2010

Change (%)

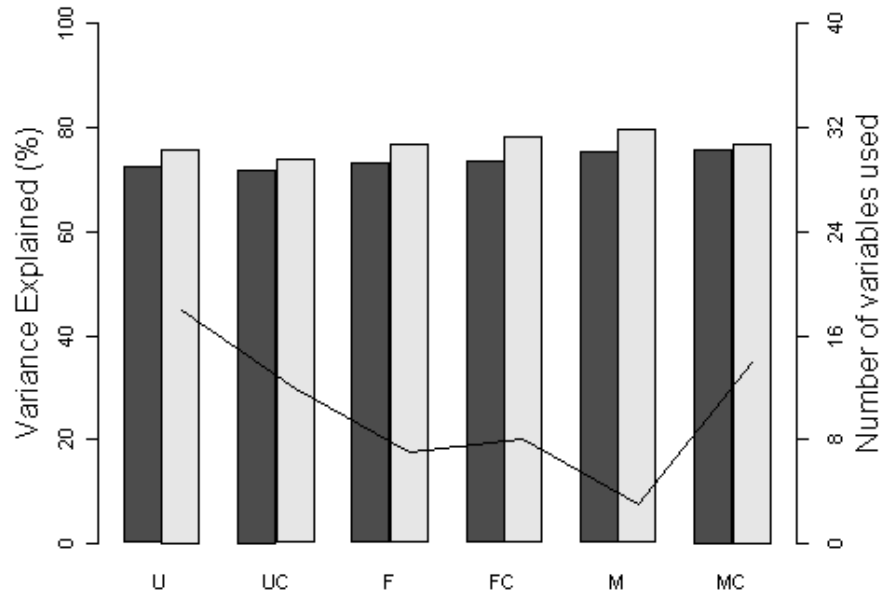# Results – outputs
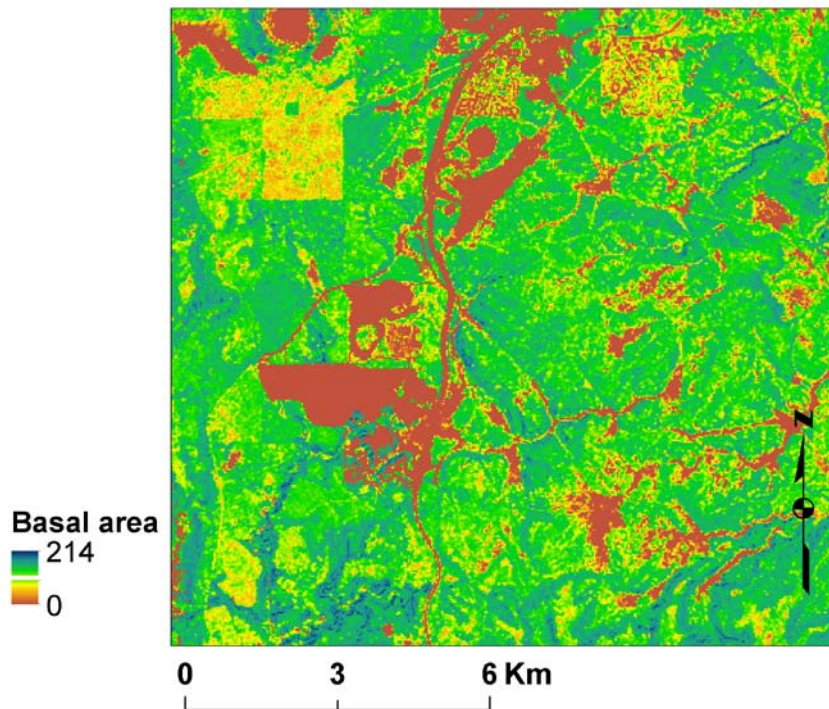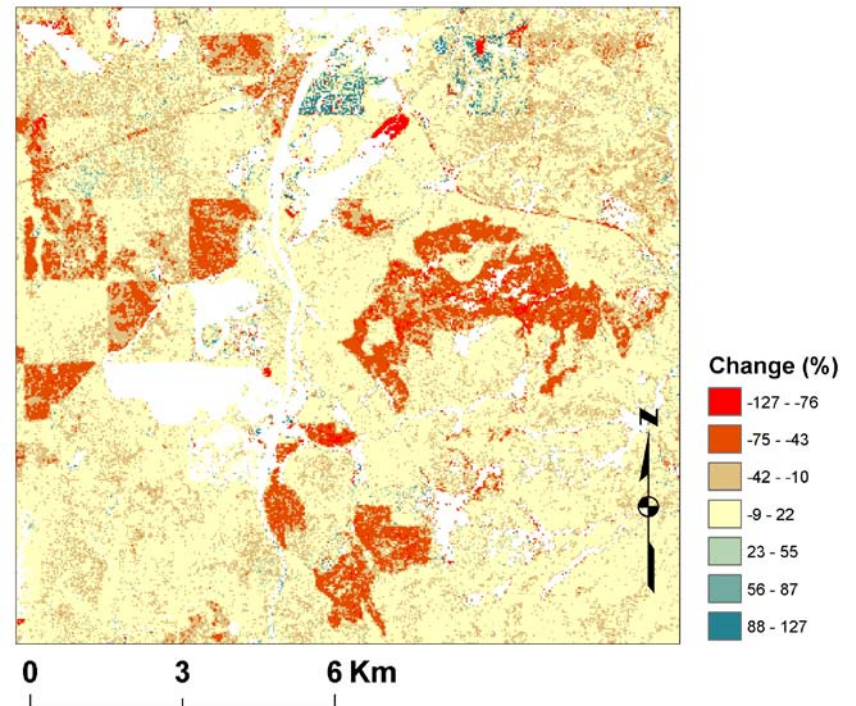
2006

2010

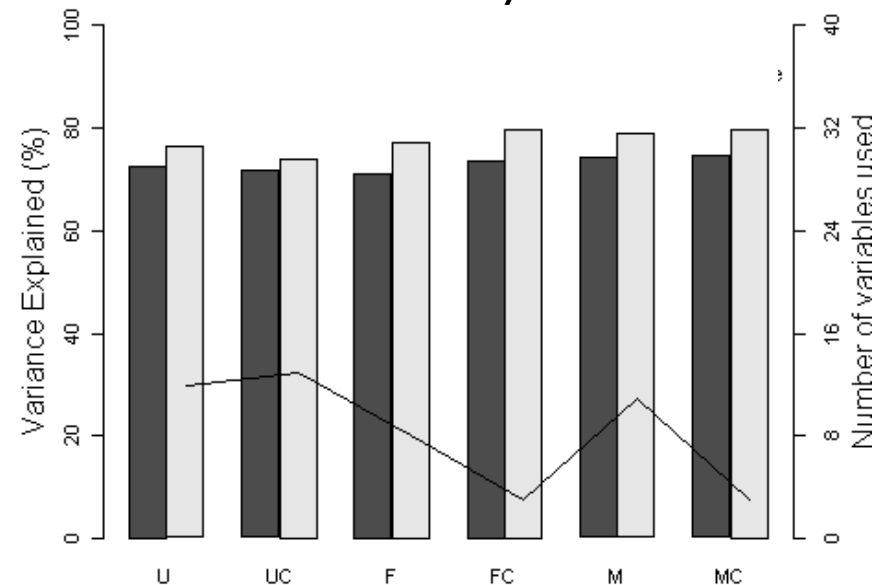# Results – Validation

Basal Area – Predicted vs. Actual
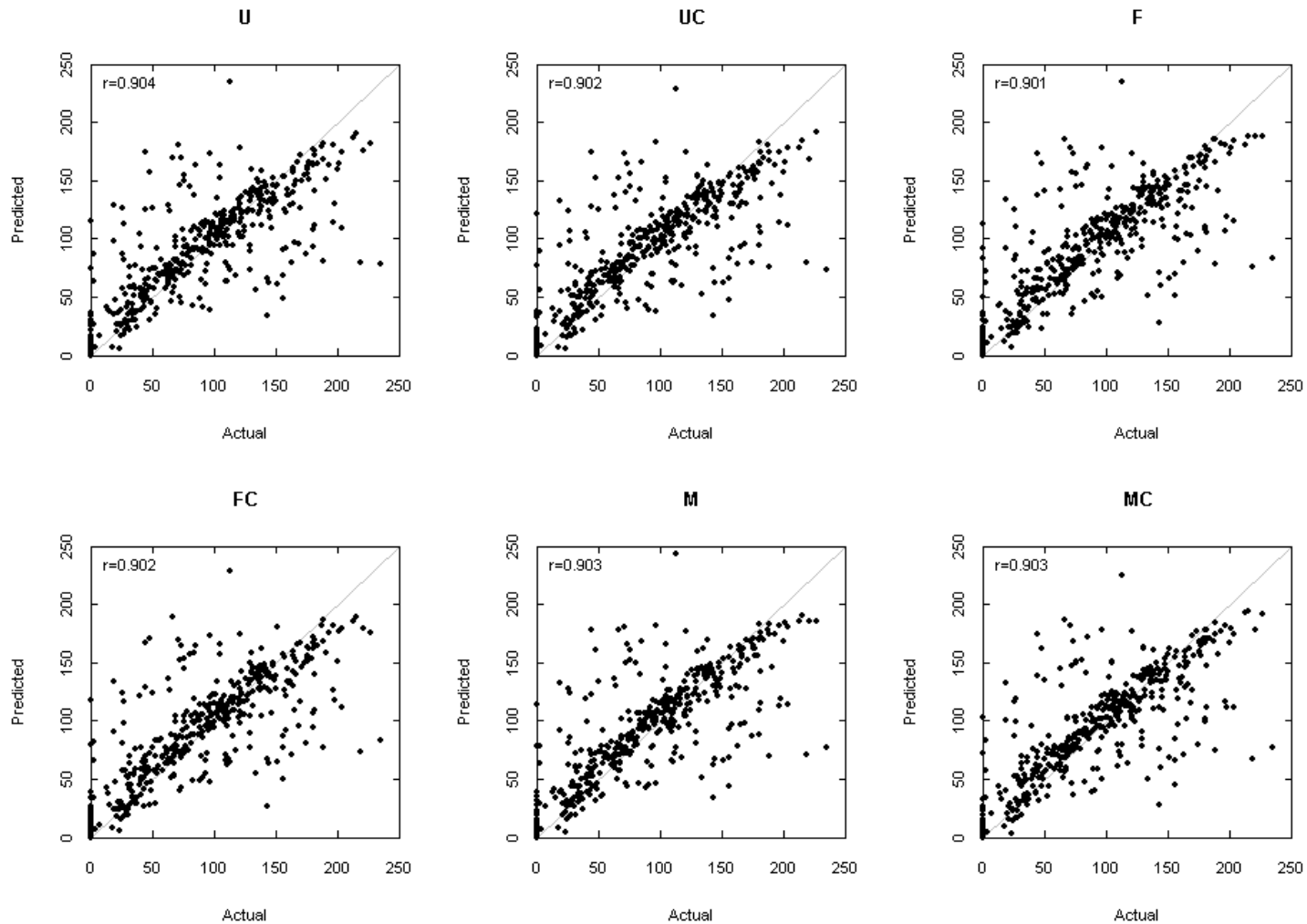
Results – Validation

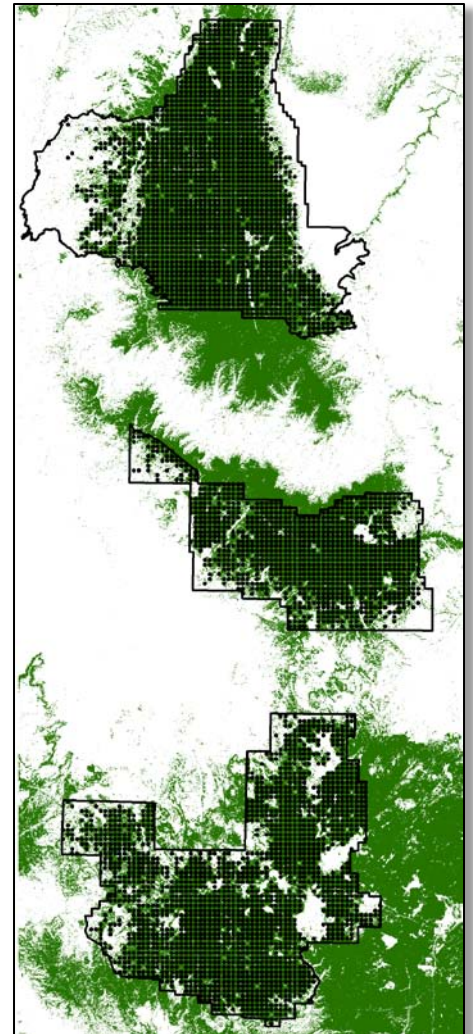Basal area

Stand Density Index

All predictors   Best subset   —— Number of predictors

Results – Consistency

Compare 2006 and 2010 basal area

❑ 1km x 1km points ($n = 4622$)

❑ Pearson correlation coefficients
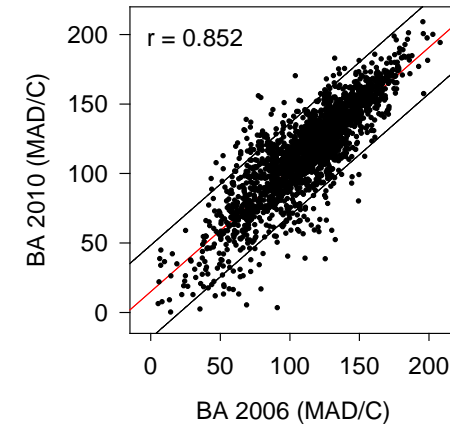
❑ Kruskal-Wallis One Way ANOVA on Ranks

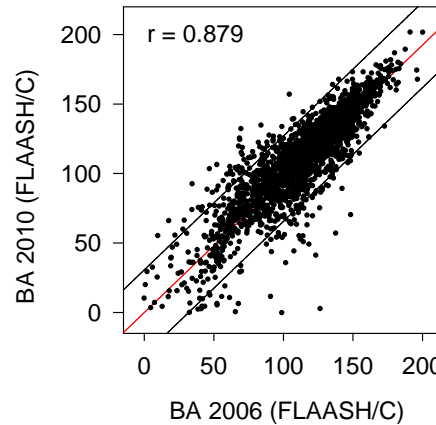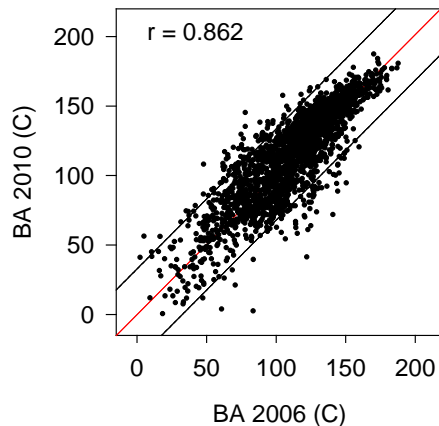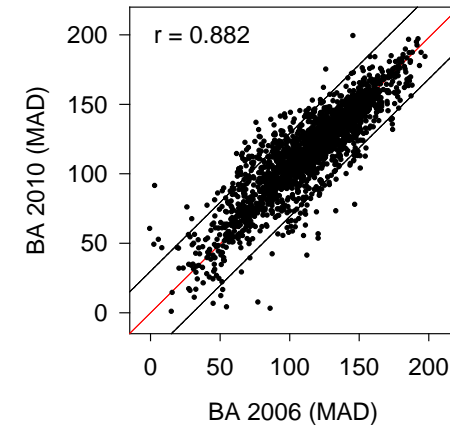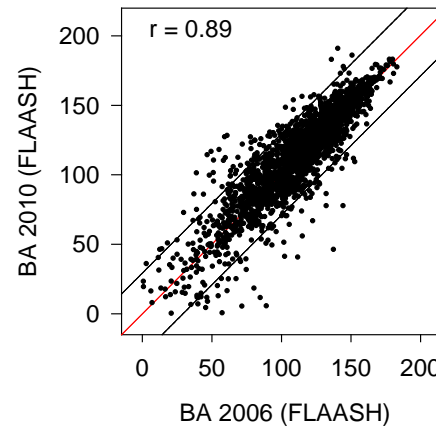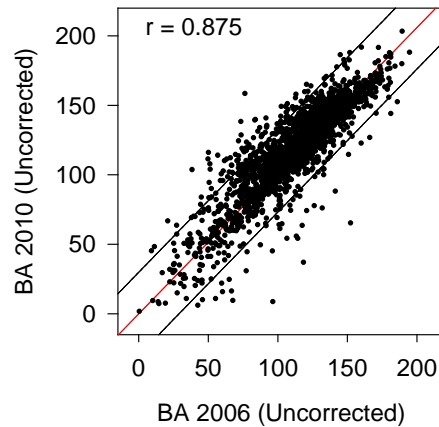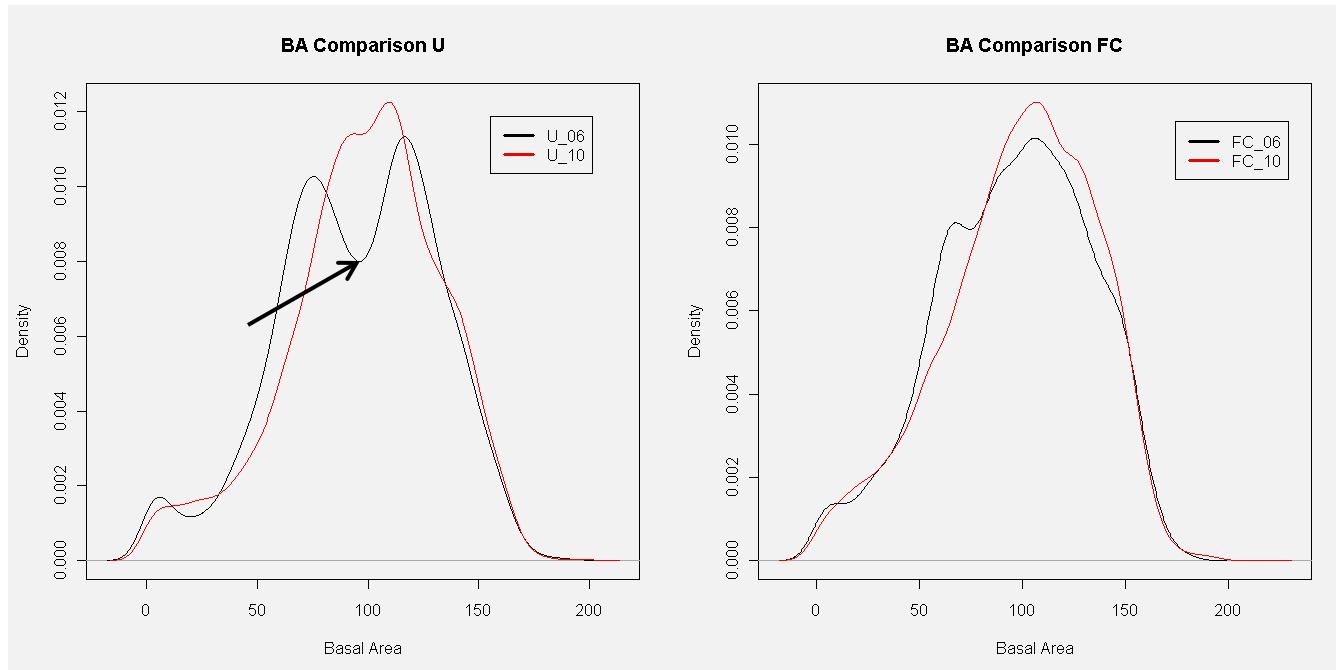# Results – Consistency

Between years for each correction technique (Basal area)

Results – Consistency

2006 basal area, H = 33.927 (P = <0.001)
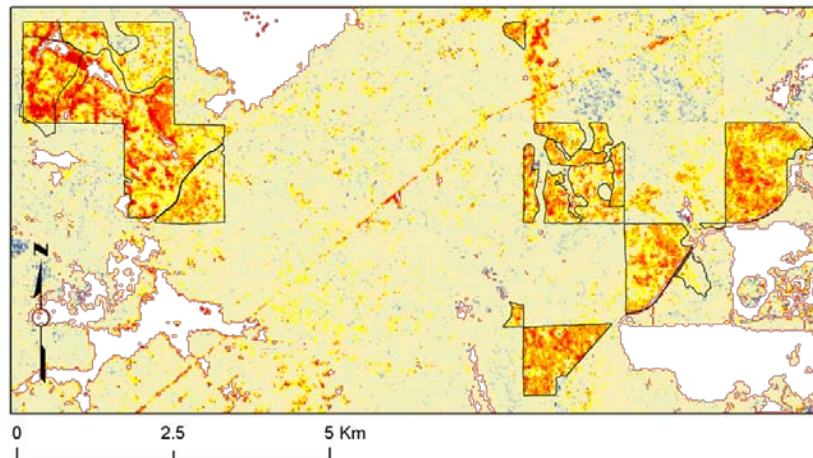2010 basal area, H = 26.090 (P = <0.001)
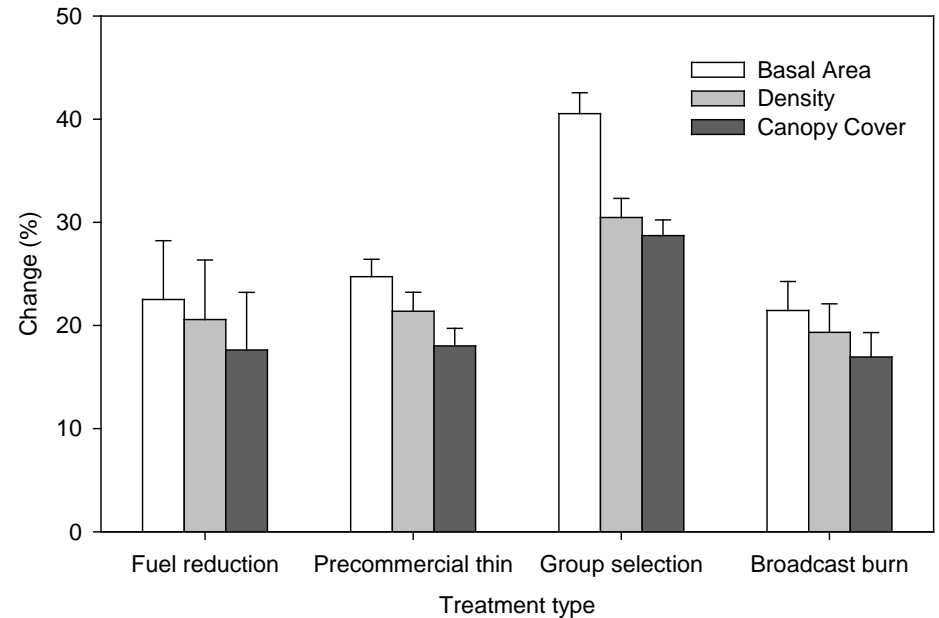
Monitoring applications

Stand density index (SDI)

SDI change (%)

0   2.5   5 Km
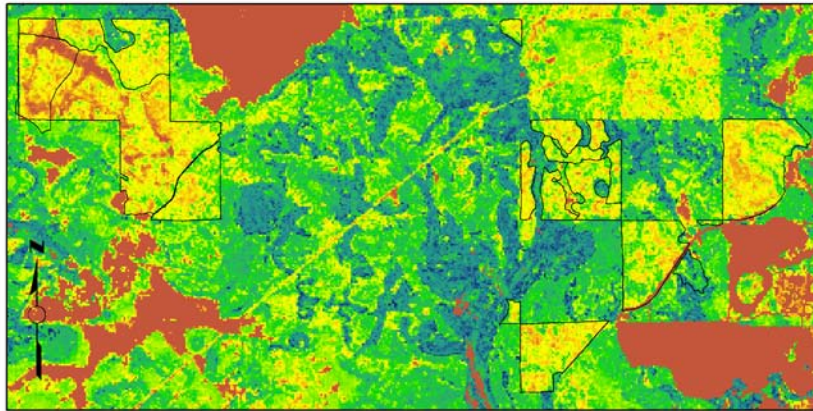
Treatment types 2006 - 2010

Conclusions

- ☐ Terrain and atmospheric corrections important

- ☐ We are likely to witness large and small disturbance events in the future

- ☐ Forest structure data are consistent & sensitive to a variety of disturbance factors

- ☐ The outputs support a range on of landscape scale analyses

Acknowledgments

- Kaibab National Forest

- USFS Forest Inventory and Analysis program, Ogden UT

- USFS Region 3 Office

- US Fish & Wildlife Service