



MAPPING BEETLE INFESTED STANDS IN MEDICINE BOW NATIONAL FOREST: IMPORTANCE OF SPATIAL AND ATTRIBUTE ACCURACY OF FIELD DATA

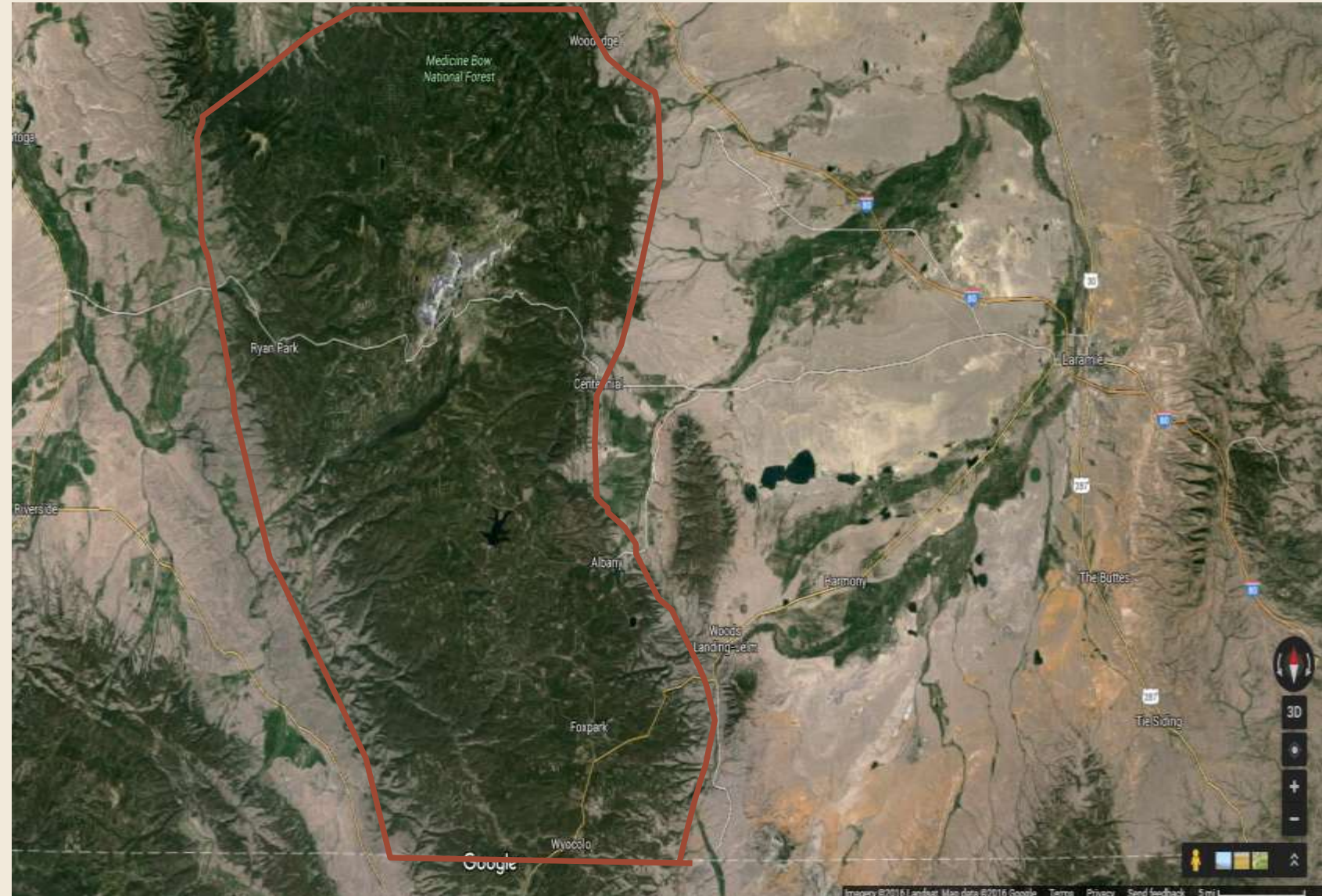
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OVERVIEW

Using tree data collected in the Medicine Bow Forest, this presentation will show the early processing of field data to prepare for creation of land cover maps

- Tree to plot level
- Plot level to pixel assignment



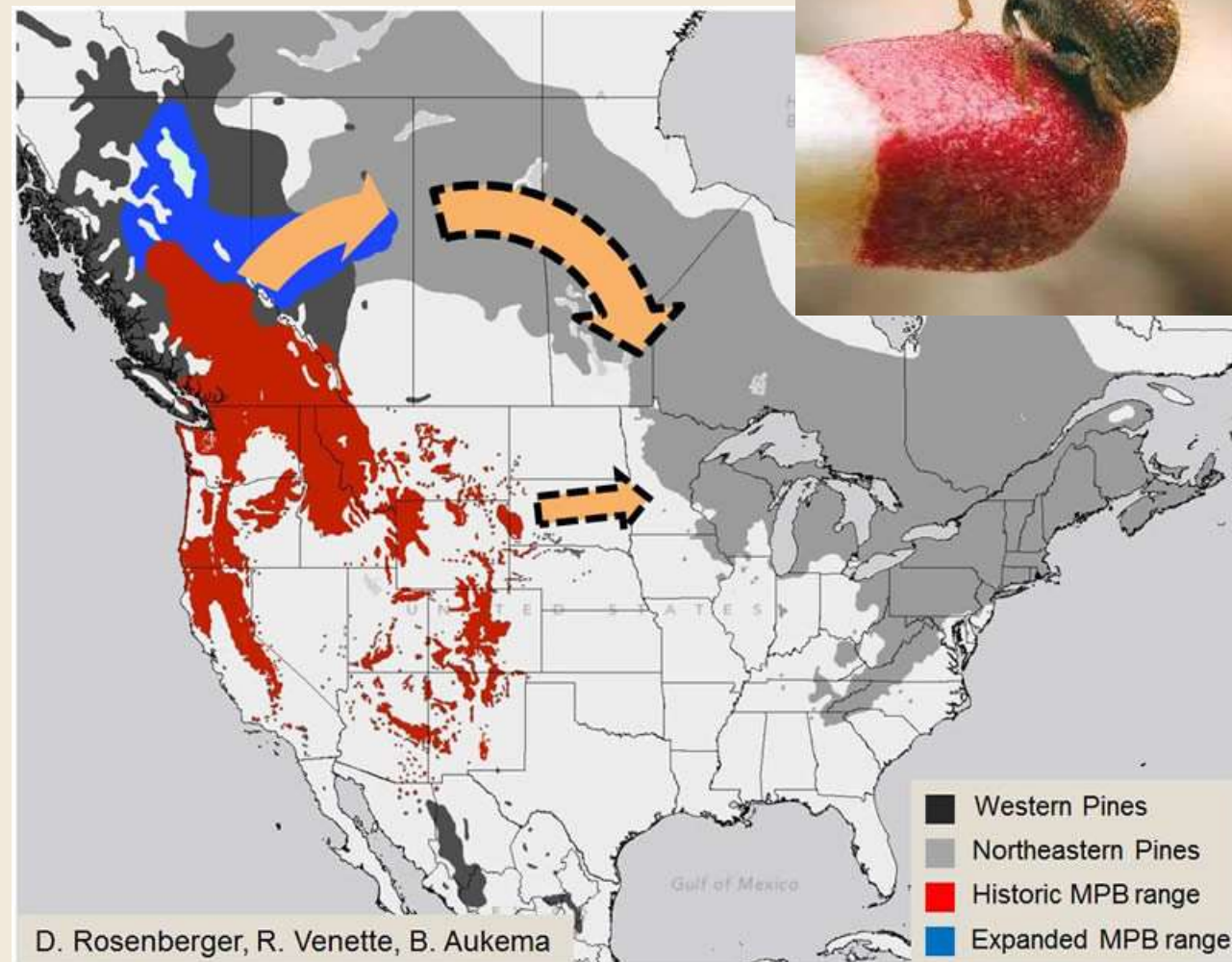
MOUNTAIN PINE BEETLE BACKGROUND

Millions of hectares from southern Rocky Mtn. to northern British Columbia¹

Colonizes several pine species¹

- Lodgepole Pine
- Ponderosa Pine
- Sugar Pine
- Limbar Pine
- Western White Pine
- Whitebark Pine

Later winter freezes allowing for shifts in species ranges²



<http://www.mda.state.mn.us/plants/insects/mpb.aspx>

¹ Jenkins, Michael J., Justin B. Runyon, Christopher J. Fetting, Wesley G. Page, Barbara J. Bentz. 2014. "Interactions among the Mountain Pine Beetle, Fires and Fuels". *Forest Science*. 60: 489-501

² Keeling et al. 2013. "Draft genome of the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, a major forest pest", *Genome Biology*. 14:R27

MOUNTAIN PINE BEETLE AFFECTS ON TREES

Pheromone-mediated mass attacks²

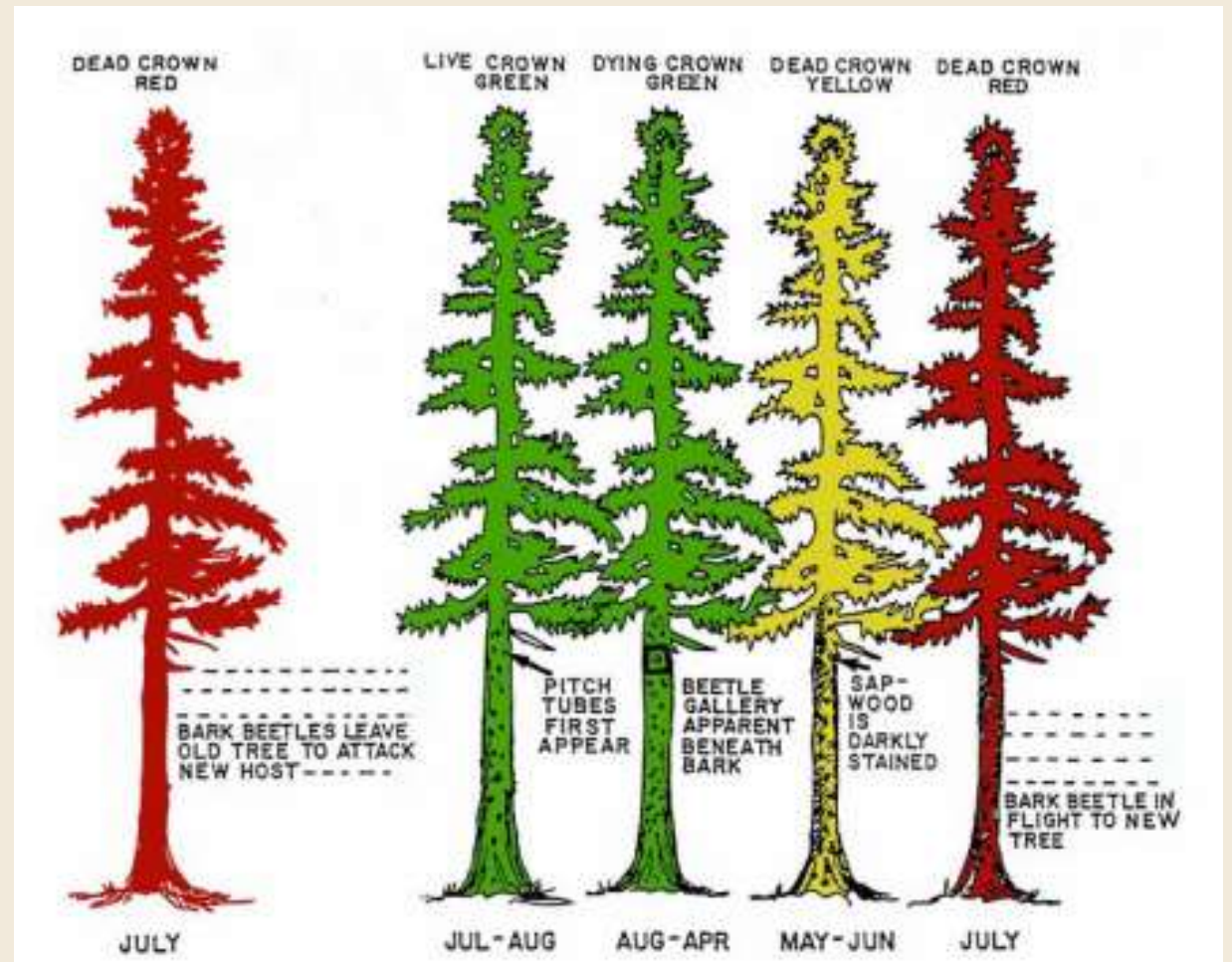
Fungi Relationship²

Stages of Attack

- Lose hydrologic conductivity
- Green needles turn red and grey
- Tree mortality



<https://www.oregon.gov/ODF/Documents/ForestBenefits/mtnpinebeetle.pdf>



<https://www.oregon.gov/ODF/Documents/ForestBenefits/mtnpinebeetle.pdf>

¹ Keeling et al. 2013. "Draft genome of the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, a major forest pest", *Genome Biology*. 14:R27

OTHERS

Other species of Conifers

- Lodgepole Pine
- Engelmann Spruce
- Subalpine Fir
- Limber Pine

Lodgepole Pine



<http://www.fs.fed.us/database/feis/plants/tree/pinconl/all.html>

Engelmann Spruce



http://klett.agsci.colostate.edu/h221/condescr1/Picea_engelmanii.html

WHY SEPARATE THE CONIFERS

Water conductivity varies

After beetle attack, the mortality and recovery of each species is different

For modeling the impact of beetle outbreak

- We need to separate the conifers

LEVELS OF SEPARATION

Conifers

- Lodgepole pine



Lodgepole pine

- Live
- Red attack
- Grey attack/needles down

- Engelmann spruce



Spruce

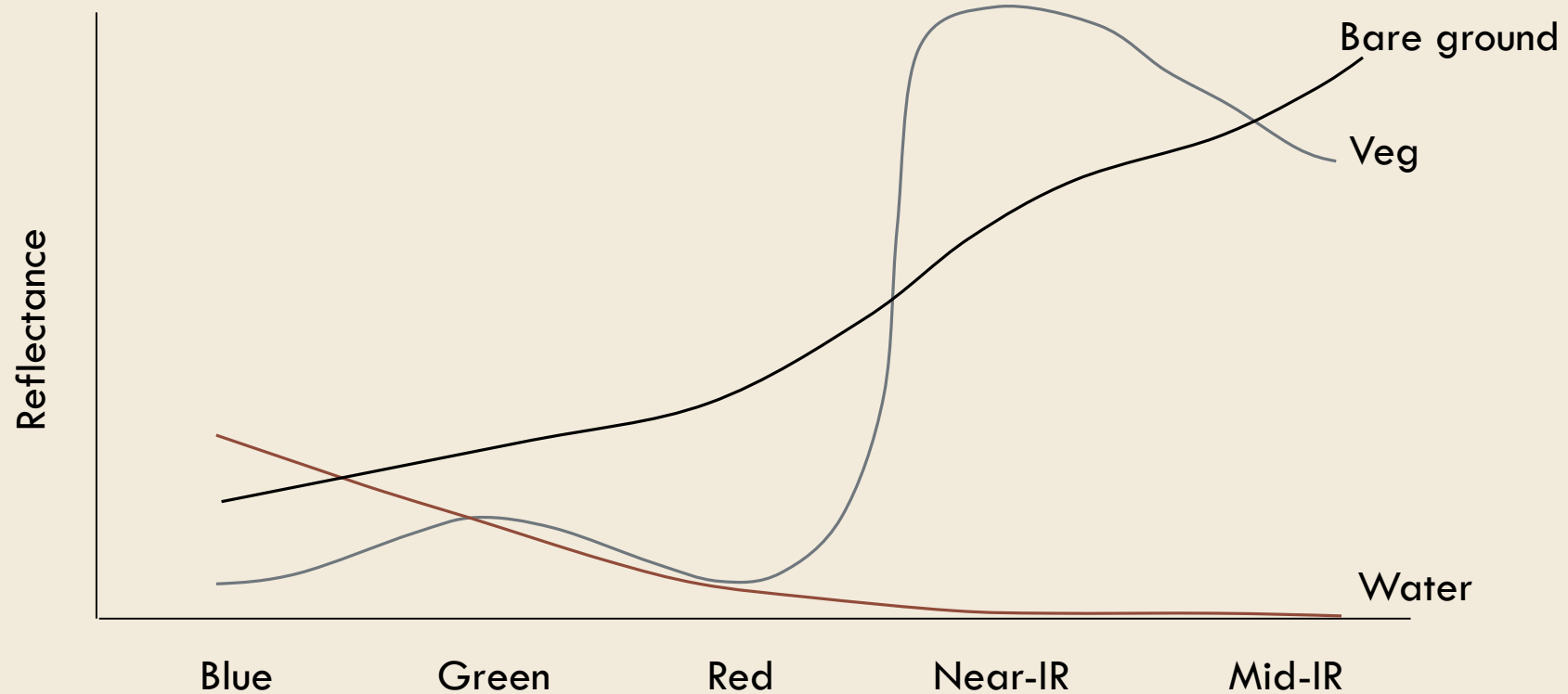
- Live
- Red attack
- Grey attack/needles down

- Subalpine fir

- ...

USES OF REMOTE SENSING

- Associating spectral reflectance values with earth surface features
- Use Remote Sensing to model ecosystem, create land cover maps over time



EXISTING PRODUCTS DERIVED FROM REMOTE SENSING DATA

National Land Cover Database

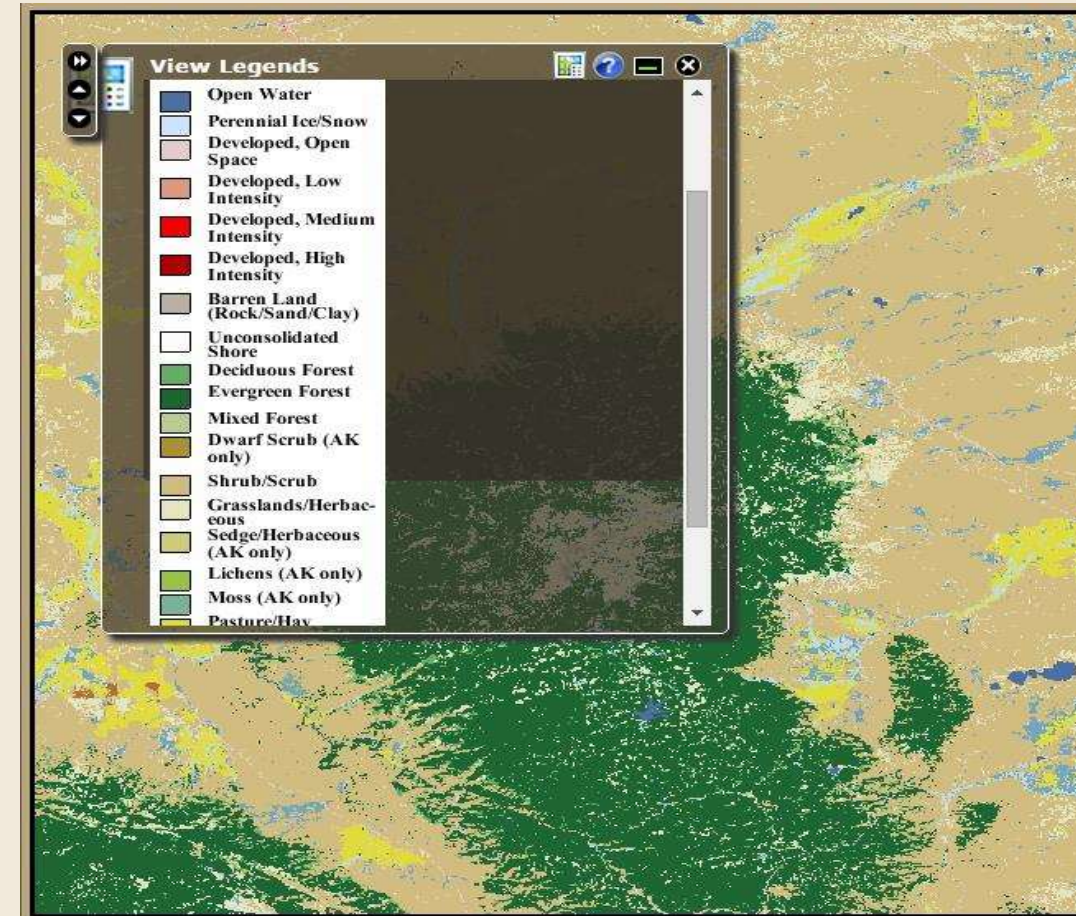
- 2001, 2006 & 2011 (Conifers, Deciduous, Mixed)

Gap Analysis Program

- 1996 & 2006 (Vegetation association level)

These products do not separate

- Conifers into different species
- By condition (live, green attack, red attack and dead)



IMPORTANCE OF FIELD DATA

- Location Accuracy
- Description
- Consistence

BB09_2	# Trees	Live	Green	Red	Dead
2008	12	12	0	0	0
2009	12	5	4	3	0
2010	30	23	5	2	0
2011	29	19	1	8	1
2012	29	18	1	3	7
2013	31	13	8	1	9
2014	33	24	0	0	9
2015	31	22	0	0	9

FIELD DATA USED

2008-2015: WYCEHG

- Collected by Ewers' lab in Botany
- Plot size range: 49 m² – 150 m²
- Data collection during warmer months typically summer

SiteID	Tree_ID	Samp_Date	Samp_Dat	Locality	PlotLengt	PlotLengt	PlotSize	SpeciesCo	Genus	Species	Family	CommonP	PlantType	Duration	Growth	BasicStruc	DBH	BasalArea	CanopyCo	CanopyCl	CanopyCo	CanopyCo	CanopyCo	Condition	Condition	TreeCond	Mortality
8807_1	1	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	35.3	9.78E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	2	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.1	4.19E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	3	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	25.9	3.43E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	4	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	29.5	0.068315	C	Codomin	Crown is	Over	BG	Beetle	Gr	Green	nei	Live
8807_1	5	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	25.7	5.18E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	6	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	33.7	8.92E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	7	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.1	4.28E-02	C	Codomin	Crown is	Over	BG	Beetle	Gr	Green	nei	Live
8807_1	8	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	31.2	7.64E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	9	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	27.6	0.059798	C	Codomin	Crown is	Over	BG	Beetle	Gr	Green	nei	Live
8807_1	10	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	29.8	6.97E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	11	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	27	5.72E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	12	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23	4.15E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	13	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	21.5	4.34E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_1	14	7/28/2008 0:00	*****	ChimneyF	10	15	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	29.8	3.40E-02	S	Suppress	Most of or	Under	M	Marginal		Suppress	Live	Live
8807_1	15	7/28/2008 0:00	*****	ChimneyF	10	15	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.3	4.34E-02	NA	Not applic	The COND	NA	DS	Dead stan	Old,	dead	Dead	Dead
8807_2	1	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	34.4	4.67E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	2	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.7	4.41E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	3	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	22.9	4.12E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	4	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	16.6	2.16E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	5	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.8	4.45E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	6	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	28.4	5.47E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	7	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	24.6	4.75E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	8	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	17.3	2.40E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	9	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	24.1	4.56E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	10	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	29.5	3.30E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	11	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.2	4.23E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	12	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	21.5	3.63E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	13	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	34.2	4.60E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	14	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	24.55	4.73E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	15	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	25.8	5.23E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	16	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.4	3.06E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_2	17	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	22.2	3.87E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_3	1	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	24.1	4.64E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_3	2	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.8	4.37E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_3	3	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	25.9	5.27E-02	C	Codomin	Crown is	Over	NA	Not recon	Not recon	NA	NA	NA
8807_3	4	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	22.6	4.01E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_3	5	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	23.6	4.37E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live
8807_3	6	7/28/2008 0:00	*****	ChimneyF	15	10	150 PICO	Pinus	contorta	Pinaceae	lodgepole	Gymnospi	Perennial	Tree	Tree	30.1	7.11E-02	C	Codomin	Crown is	Over	L	Live	Live	Live	green	Live

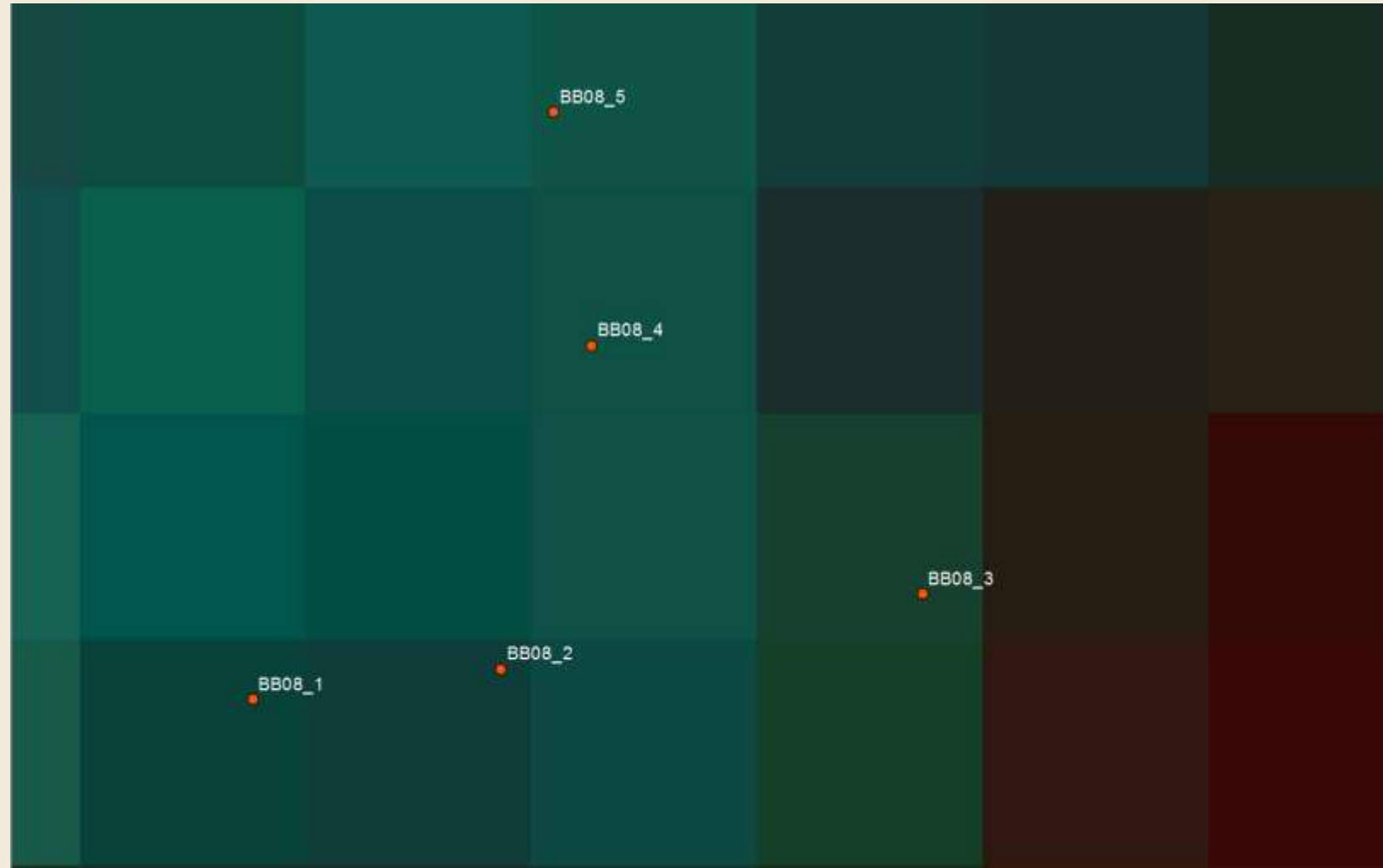
TREES TO PLOTS

	2008	2009	2010	2011	2012	2013	2014	2015
# Trees	182	219	376	831	1695	1039	482	570
# Plots	15	15	22	46	115	46	28	42

IDEAL CASE SCENARIO

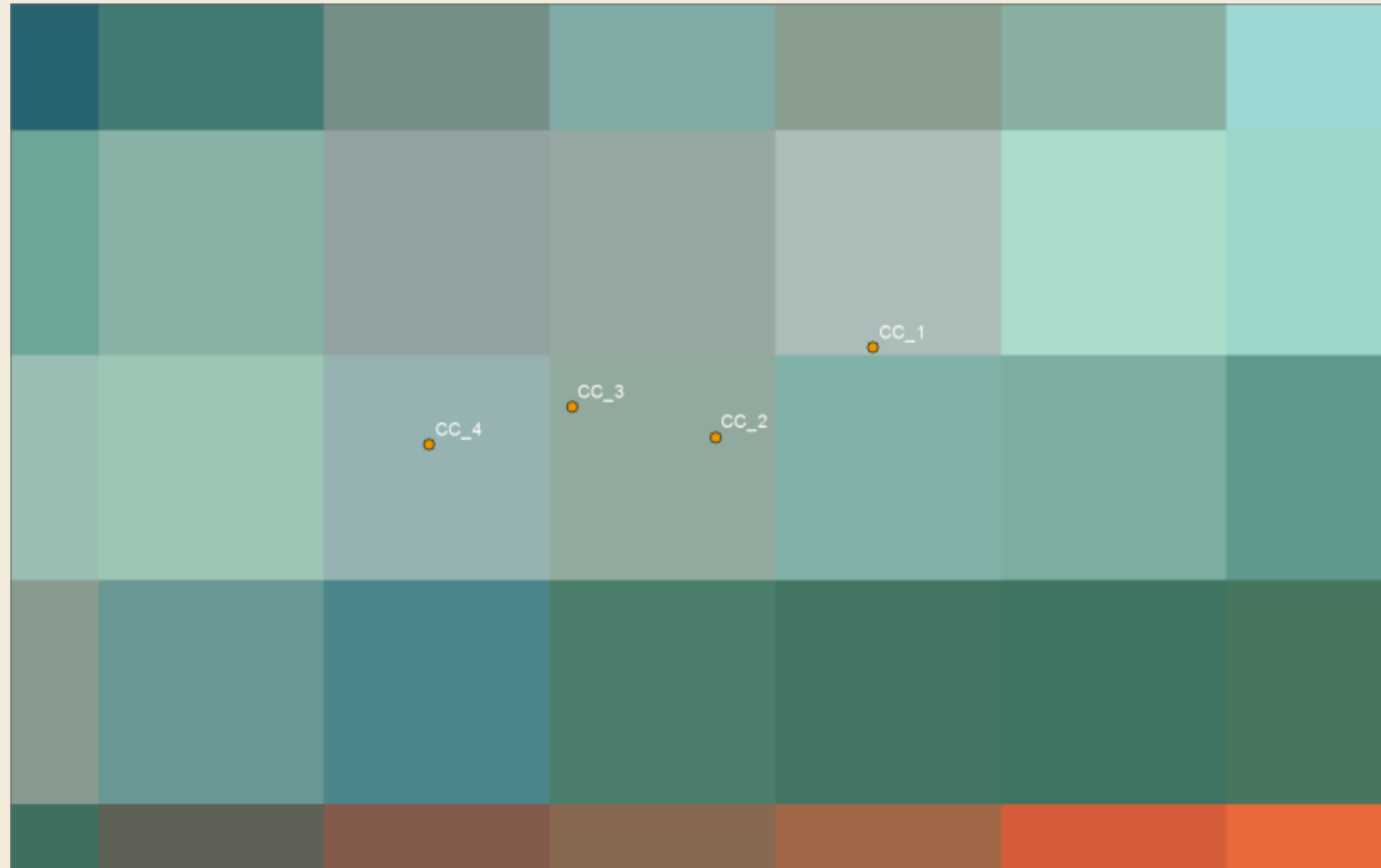
Plots are spread out – they are falling on different pixels

Independent samples



REALITY

Clustered in some regions



GROUPING OF PLOTS

Grouping

- Location first
 - In the same pixel
 - Within 62 meters
- Attributes
 - Same percentage

Variation

- Year to year changes due to attributes

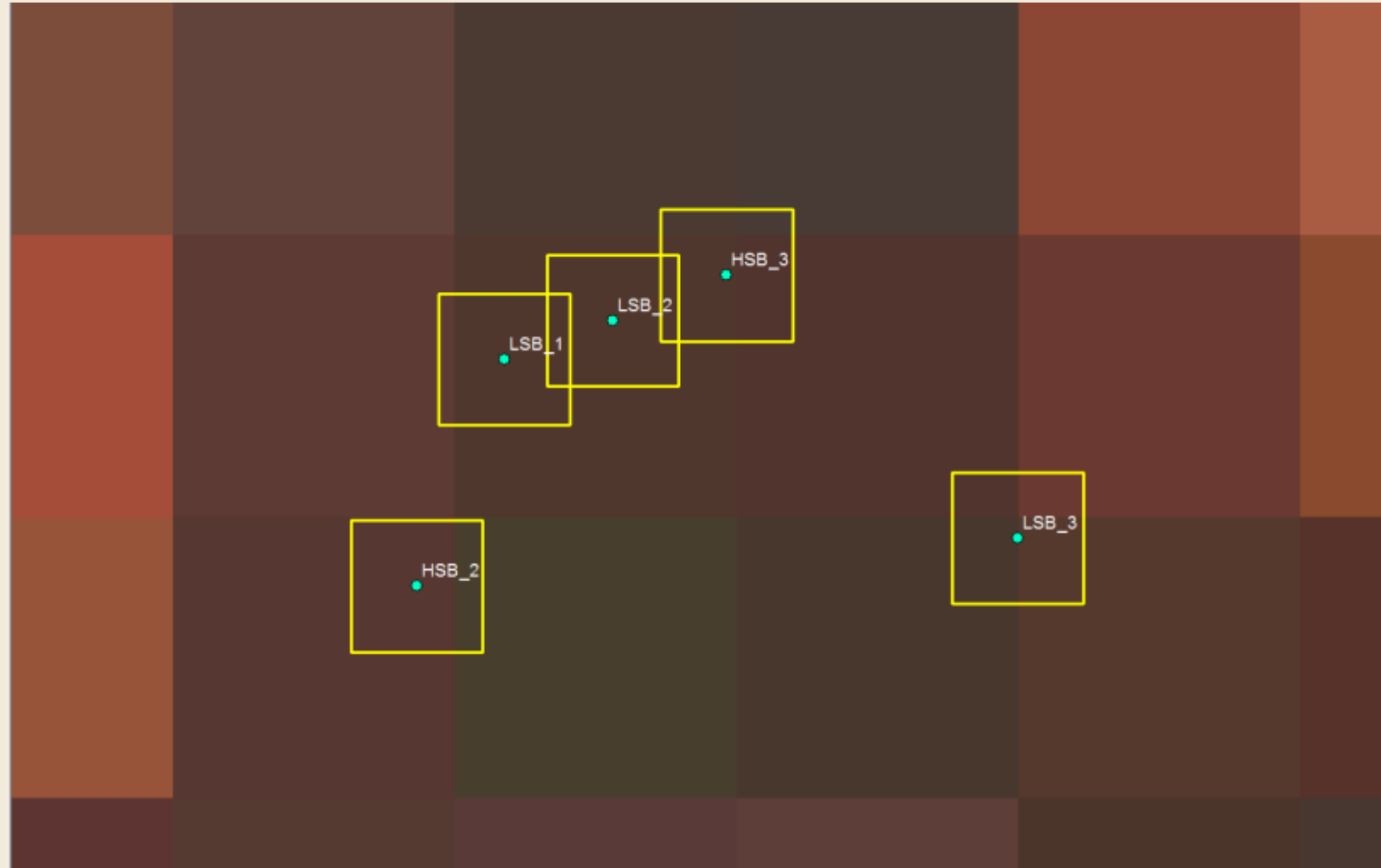
	2008	2009	2010	2011	2013	2014
# Plots	15	15	22	46	46	28
# Pixels	12	12	12	35	19	18



GROUPING OF PLOTS

Limitations

- Different plot sizes over flow into multiple pixels
- Trees within multiple plots



FUTURE WORK

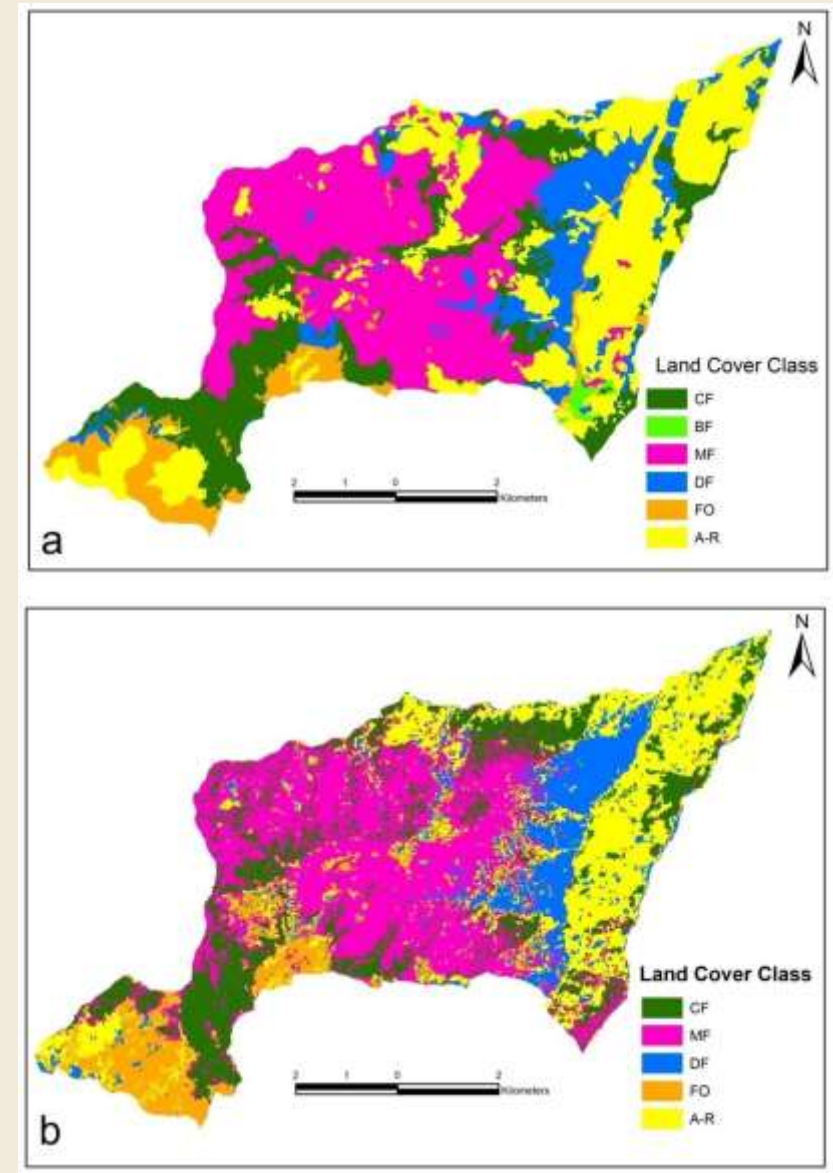
Multiple data sets

- Colorado State University with the USDA Forest Service
- Wyoming Natural Diversity Database (WYNDD)

Creating land cover maps

- Three year intervals 2000-2015

Field work to match map pixel to actual vegetation



Gunlu, Alkan, Fatih Sivrikaya, Emin Zeki Baskent, Sedat Keles, Gunay Cakir, and Ali Ihsan Kadiogullari. 2008. "Estimation of Stand Type Parameters and Land Cover Using Landsat-7 ETM Image: A Case Study from Turkey." *Sensors*. 8(4): 2509-2525.

REFLECTIONS

- Quality Field Work is necessary
 - Detailed descriptions of field sites and locations
 - Variations of plot data changes year to year with collection team, time of year, and mortality of trees
- Learning new techniques with remote sensing
- Ability to work with data that is not specifically collected with remote sensing applications in mind

QUESTIONS?



Medicine Bow National Forest -2002



Medicine Bow National Forest -2010