Comparing Inventory Methods

quality and value

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President, SilviaTerra

Field Tech Meeting - Fall 2015

Why this is worth your time

- You're going to encounter this, and it's worth considering risk and reward of approaches.

- How we transition from research to application of remotely sensed data is important because we have a responsibility to protect the innocent.

Because these are real problems

- rising costs,
- landowner changes,
- increased competition,
- environmental awareness and un-awareness,
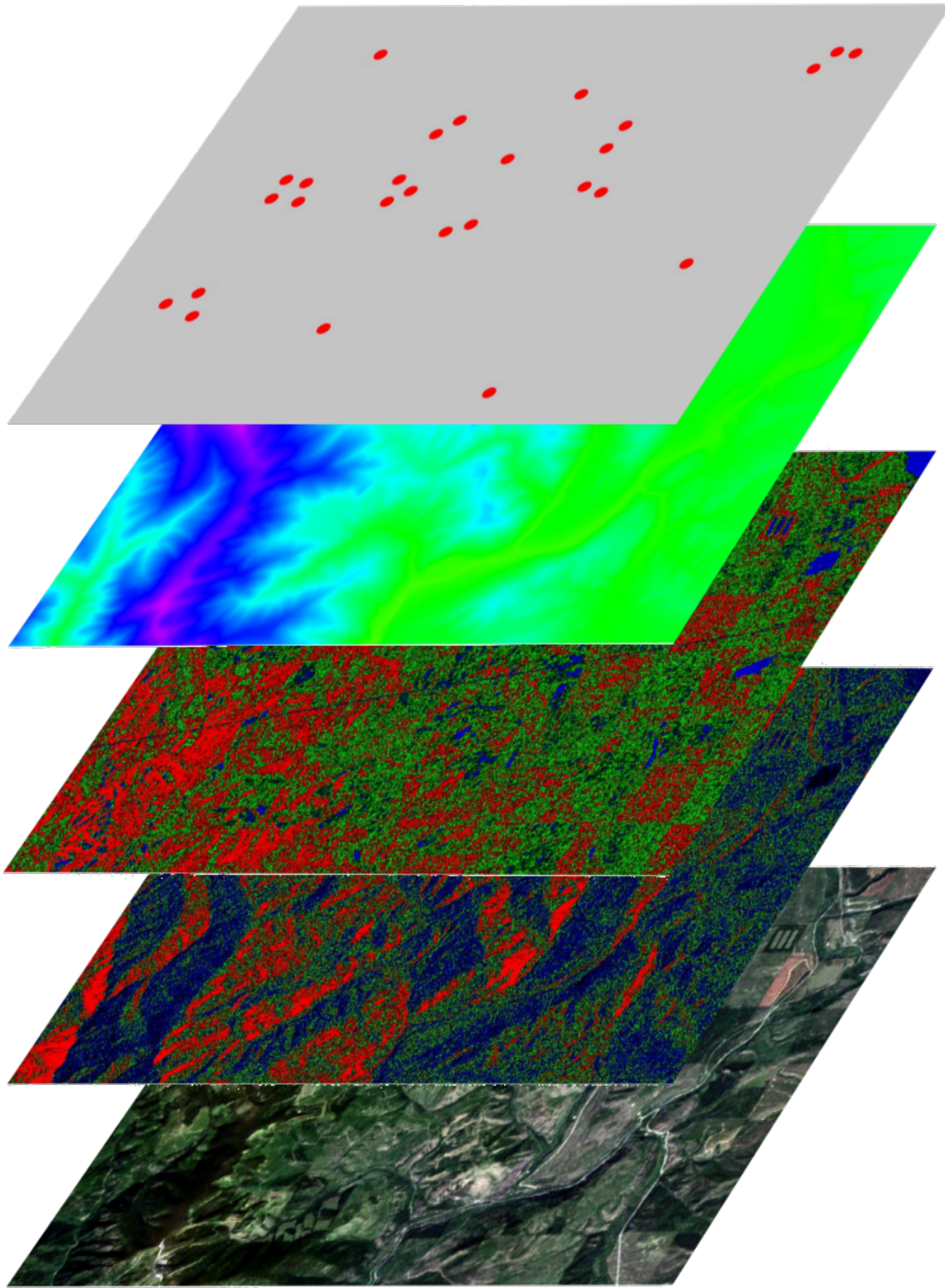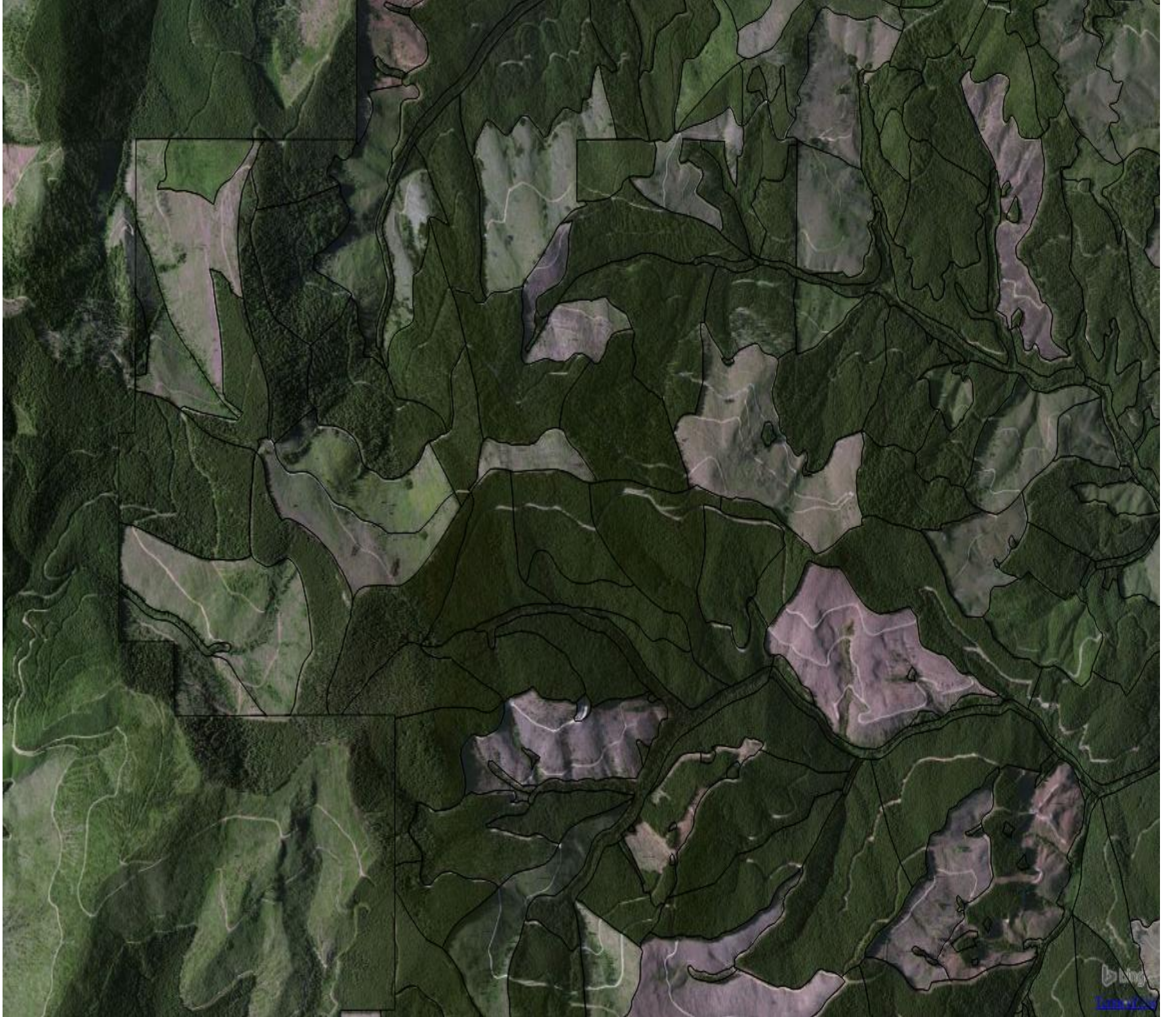- market shifts in forest-derived products

This wasn't the plan.

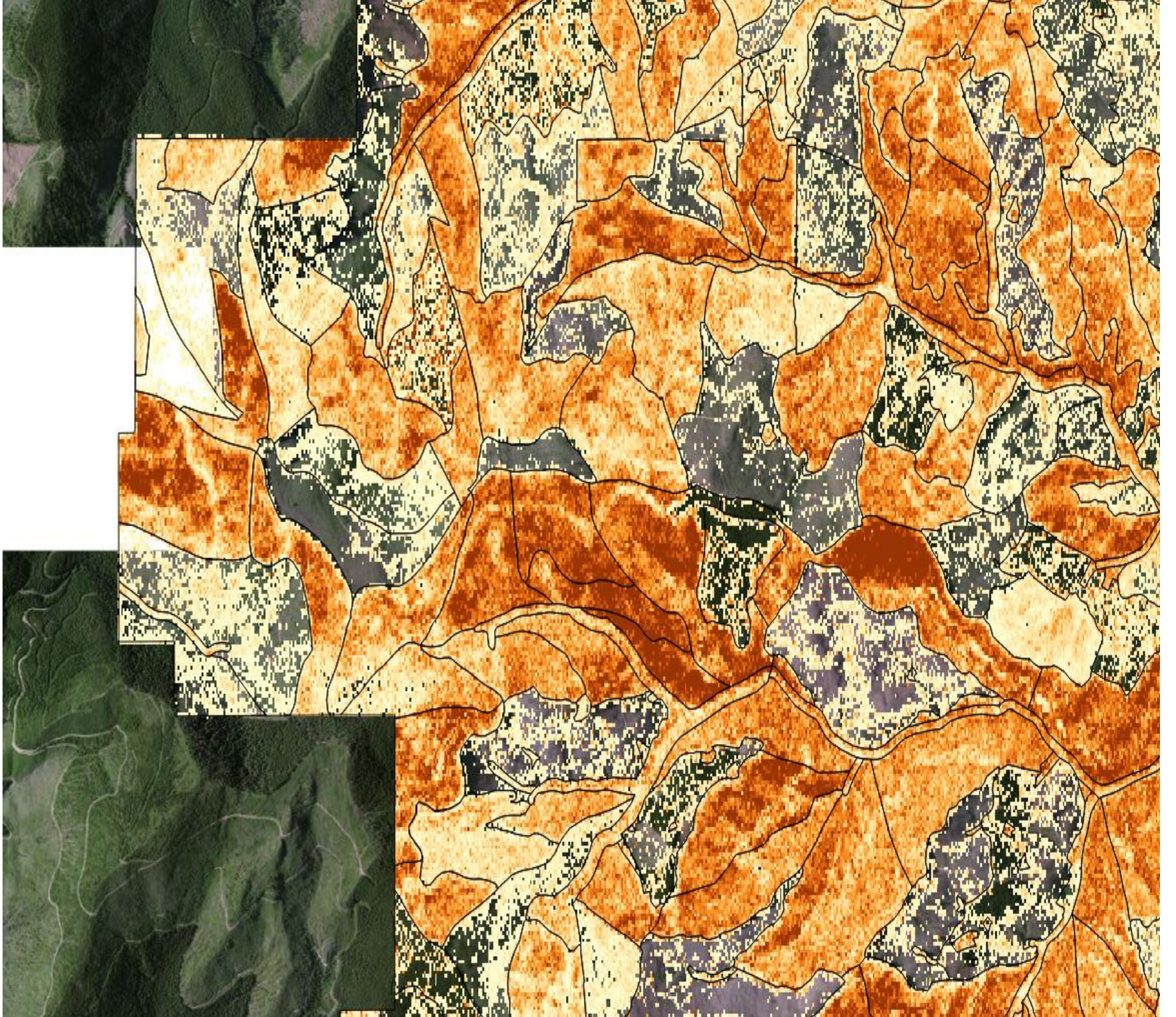I got into this by trying to solve my own problem(s).

And ended up focusing on building the things I wished existed.

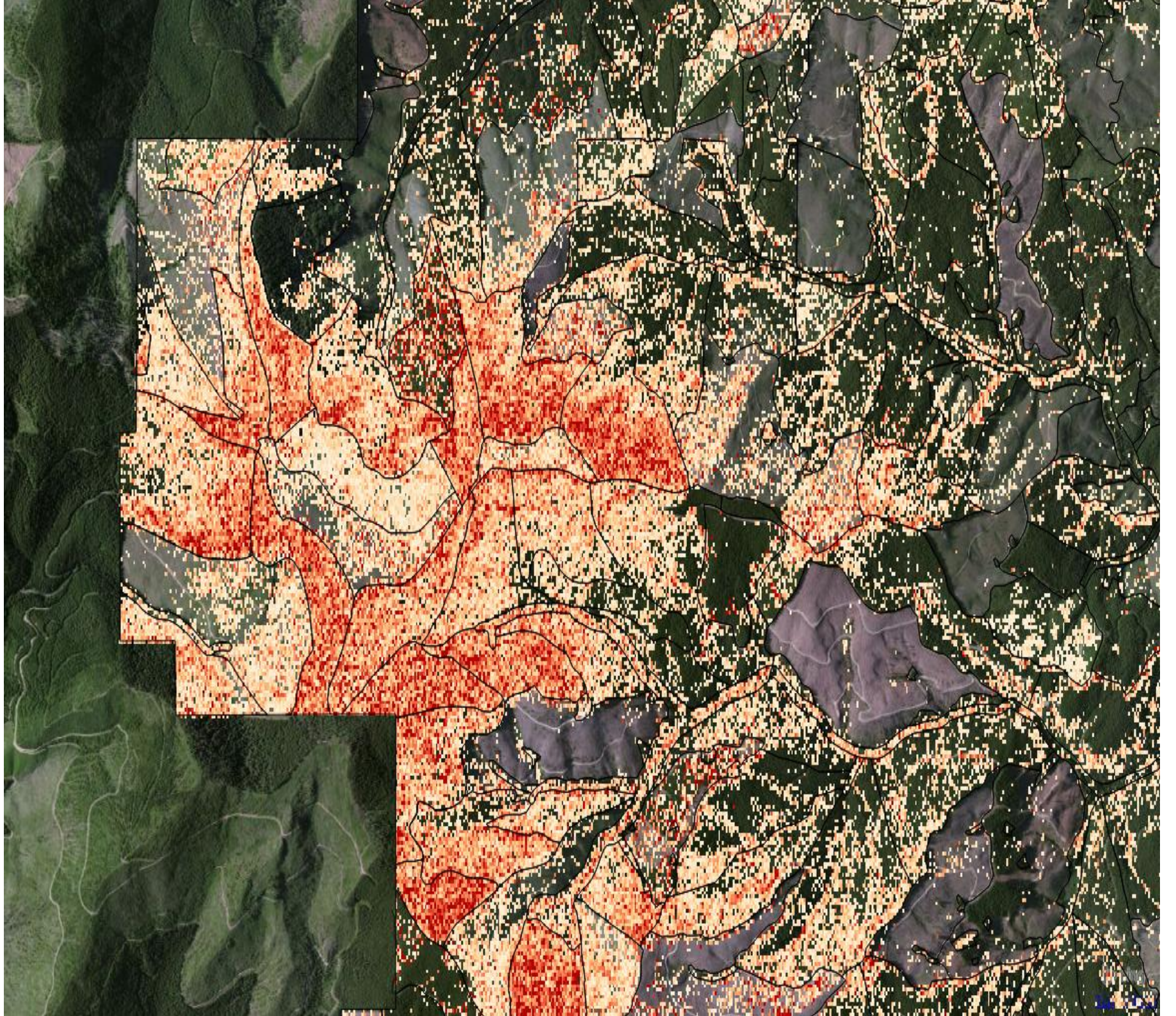# PLOT HOUND

Cruise details
12 plots

Biltmore Estate Tract 001
(Transylvania, NC)

266 acres	12 plots	0% complete

Plot #1
3,231 ft.
Biltmore Estate Tract 001
(Transylvania, NC)
Assigned to **Paul Bunyan**   No trees recorded

Plot #2
3,231 ft.
Biltmore Estate Tract 001
(Transylvania, NC)
Assigned to **Paul Bunyan**   No trees recorded

Plot #3
3,231 ft.
Biltmore Estate Tract 001
(Transylvania, NC)
Assigned to **Paul Bunyan**   No trees recorded

Plot #4
3,231 ft.
Biltmore Estate Tract 001
(Transylvania, NC)
Assigned to **Paul Bunyan**   No trees recorded

Plot #5
3,231 ft.

Distance to destination (feet)
716140 BRP
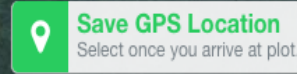
Heading
259° (W)

Accuracy (feet)
220

⚑ Save GPS Location
Select once you arrive at plot.

US 276

Big East BRP

US 276

Wolf Ford

BRP

US 276

US 276

FS 475

US 276

Mine
Mountain Estates

📍 35.326368254016 -82.760043091947
🔼 35.972724899999996 -78.9554631

Plot #1
Biltmore Estate Tract 001

↓ Limiting Distance Calculator ↓

Sampling method	Plot notes
BAF 10	

	Species	Diameter (DBH)	Total height	Merch. height	Grade	Flag	
1	black oak	11 inches				☐	more ⌄
2	black oak	12 inches	44 feet	16 feet	saw	☐	more ⌄

	Species	Diameter (DBH)	Total height	Merch. height	Grade	Flag	
3	chestnut oak	7 inches				☑	less ⌃
	Age	Crown ratio	Defects	Tree notes			
	20 years	30%	1 defect				

	Species	Diameter (DBH)	Total height	Merch. height	Grade	Flag	
4						☐	more ⌄

✖ Edit trees   **✔ Complete plot**   **✖ Drop plot**

Demo Stand

created on Aug. 22, 2014
by Paul Bunyan

19 acres

Create Cruise

Download stand KML
Download stand SHP
Delete Stand

Bullitt, KY   expand

+ add tag

Cruises

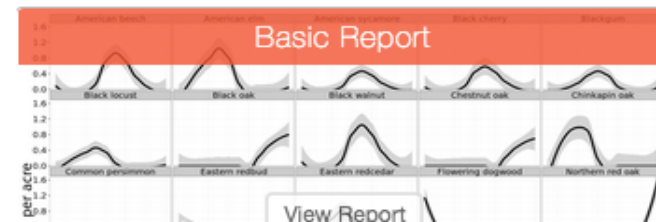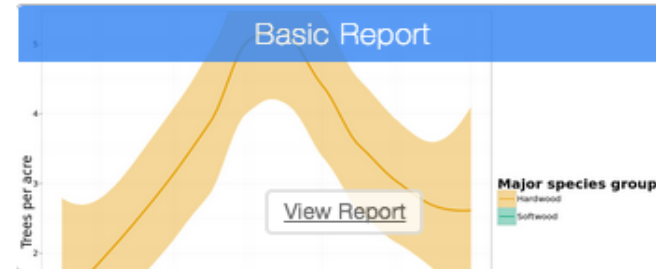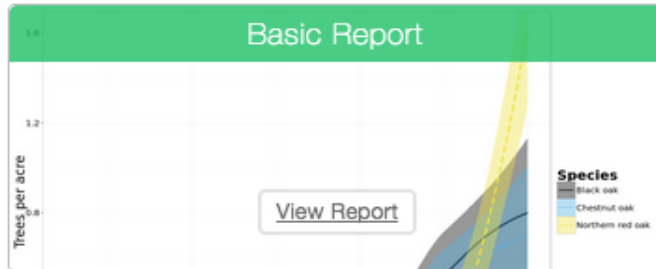| Demo Stand Bullitt, KY	Started 8/22/14	Finished 8/22/14	Cruised by Paul... ⊕	Acres 19	Plots 34	TPA? 42	BA? 28	QMD? 10.8

Create check cruise   Delete Cruise

Basic Report

View Report

Species
Black oak
Chestnut oak
Northern red oak

Basic Report

View Report

Major species group
Hardwood
Softwood

Basic Report

American elm
American sycamore
Black cherry
Blackgum
Black locust
Black oak
Black walnut
Chestnut oak
Chinkapin oak
Common persimmon
Eastern redbud
Eastern redcedar

View Report

Basic Report

American beech   American sycamore   Black cherry   Blackgum

Black locust   Black oak   Black walnut   Chestnut oak   Chinkapin oak

Common persimmon   Eastern redbud   Eastern redcedar   Flowering dogwood   Northern red oak

View Report

Species
- Black oak
- Chestnut oak
- Northern red oak

Trees per acre

View Report

Major species group
- Hardwood
- Softwood

Trees per acre

View Report

Basic Report

Trees per acre

- American elm
- American sycamore
- Black cherry
- Blackgum
- Black locust
- Black oak
- Black walnut
- Chestnut oak
- Chinkapin oak
- Common persimmon
- Eastern redbud
- Eastern redcedar
- Flowering dogwood
- Northern red oak
- Pignut hickory

View Report

Basic Report

American beech | American elm | American sycamore | Black cherry | Blackgum
Black locust | Black oak | Black walnut | Chestnut oak | Chinkapin oak
Common persimmon | Eastern redbud | Eastern redcedar | Flowering dogwood | Northern red oak
Pignut hickory | Red maple | Sassafras | Shagbark hickory | Slippery elm

Trees per acre

View Report

Basic Report

American beech | American elm | American sycamore | Black cherry | Blackgum
Black locust | Black oak | Black walnut | Chestnut oak | Chinkapin oak
Common persimmon | Eastern redbud | Eastern redcedar | Flowering dogwood | Northern red oak
Pignut hickory | Red maple | Sassafras | Shagbark hickory | Slippery elm

Trees per acre

View Report

**Click to download:**

Basic Report   Cruise Report

Cruise KML   Cruise SHP   Cruise GPX

| Plot	Status	Collected	Cruiser	Sampling Method	Notes	Trees
1	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	4 (details)
2	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	8 (details)
3	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	8 (details)
4	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	8 (details)
5	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	1 (details)
6	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	3 (details)
7	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	7 (details)
8	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	5 (details)
9	completed	8/22/14	Paul... ⊕	1/10 acre	n/a	no trees
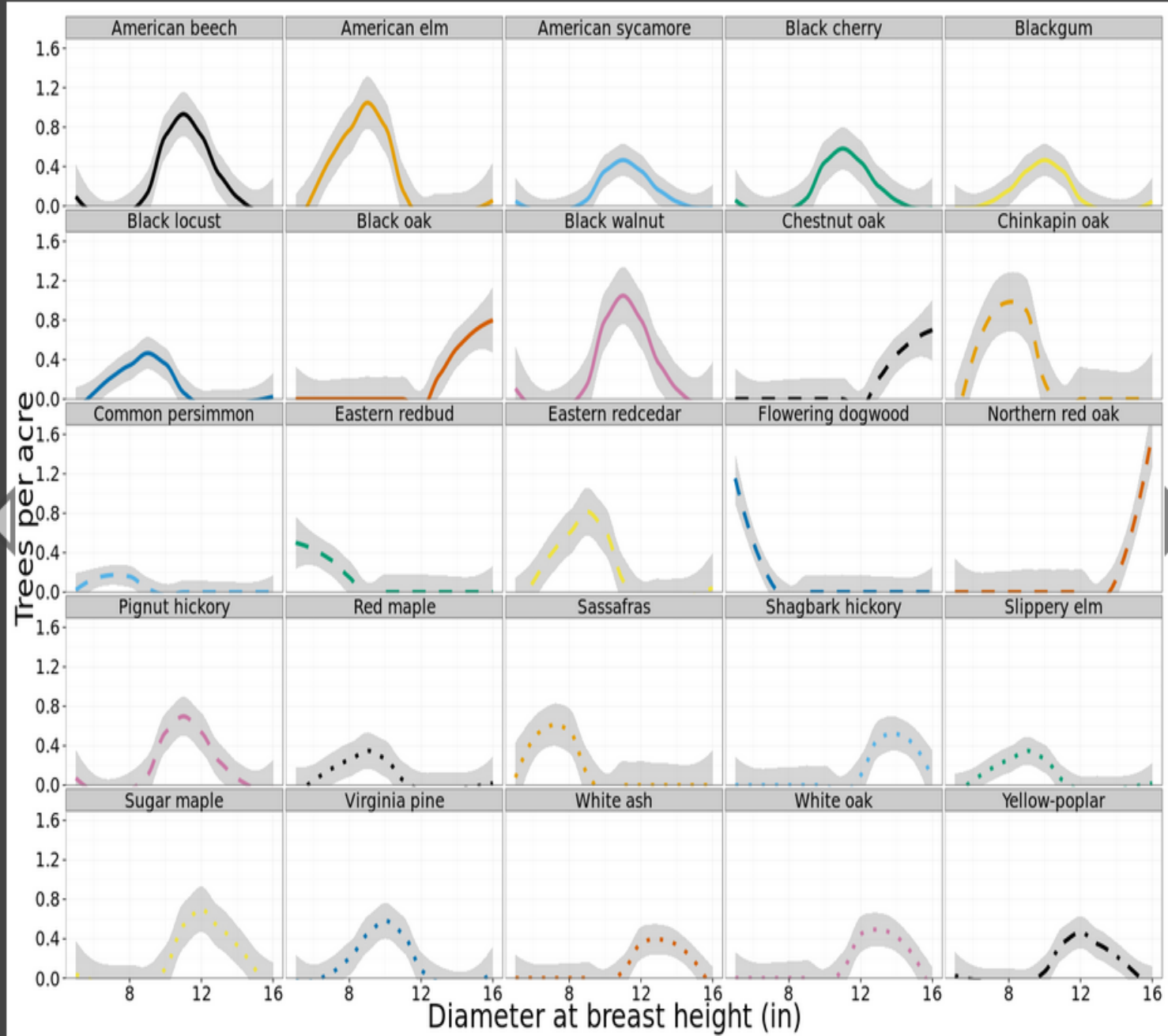
This "technology",does it work?

Real cost

- what do you pay?
- what skills do you have to learn?
- what frustrations do you have to endure?
- vs. your next best alternative
- avoiding thinking about sunk costs..

A tale of two technologies
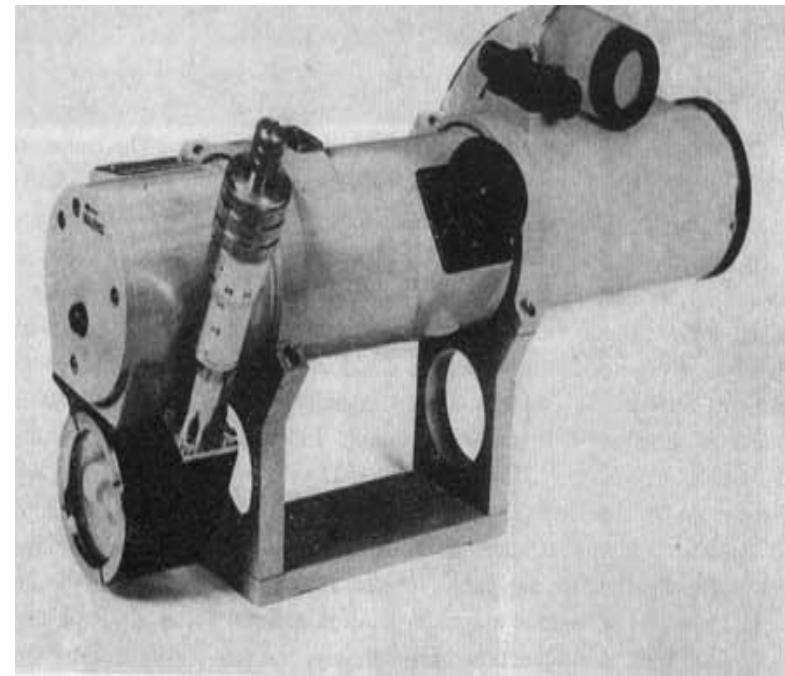
but given a bit of time...
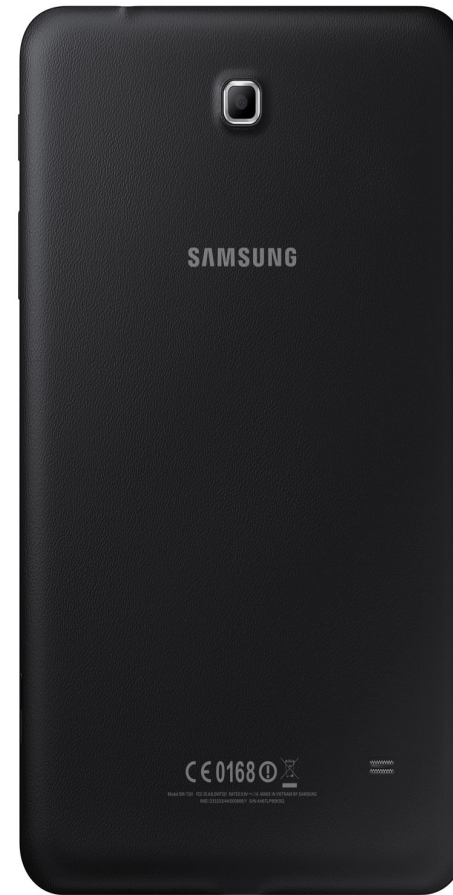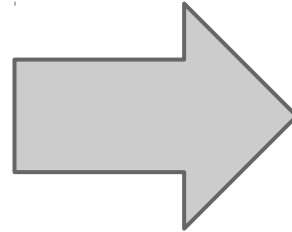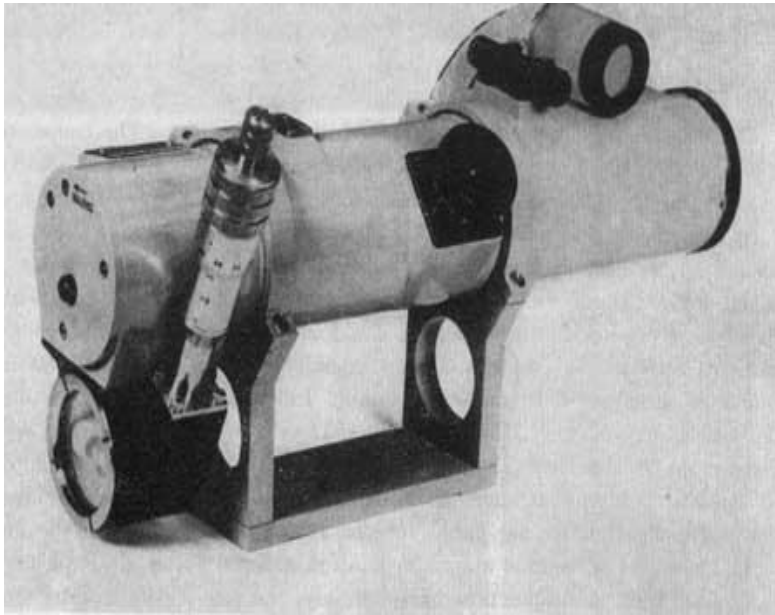
The real trends

measurements cost less
computation is cheaper and better
communication is getting … better?

The real trends

measurements cost less
computation is cheaper and better
communication is getting … better?

No picture necessary

The real trends

measurements cost less
computation is cheaper and better
communication is getting … better?

*because having data and making insights from data
  are different things.*

PBTF Forest Inventory Sampling Plan *Revised 11/14/11*

| Plantation | Pre-Merch | Intermediate Merch | Mature Merch |

Regen Monitor Surveys

Benchmark Crz 100% Annual Sample

Stand Table Crz 100% Annual Sample

Regional Inventory Variable Plot Cruise Repeated every 5 - 7 years
Increasing Intensity

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | **12** | 13 | 14 | 15 | 16 | 17 | 18 | 19 | **20** | 21 | 22 | 23 | 24 | **25** | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | **45** | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |

Fixed Area Plot Sample by Stand Boundary → **12% SE Variable Plot Sampling Statistical Targets (Bruce's Method) 6% SE**

Cruise w/o Grade by Stand Boundary → **Cruise with Grade by Harvest Unit**

Post PCT Cruise

Post Commercial Thinning Cruise

Ad Hoc Designed Surveys as Needed
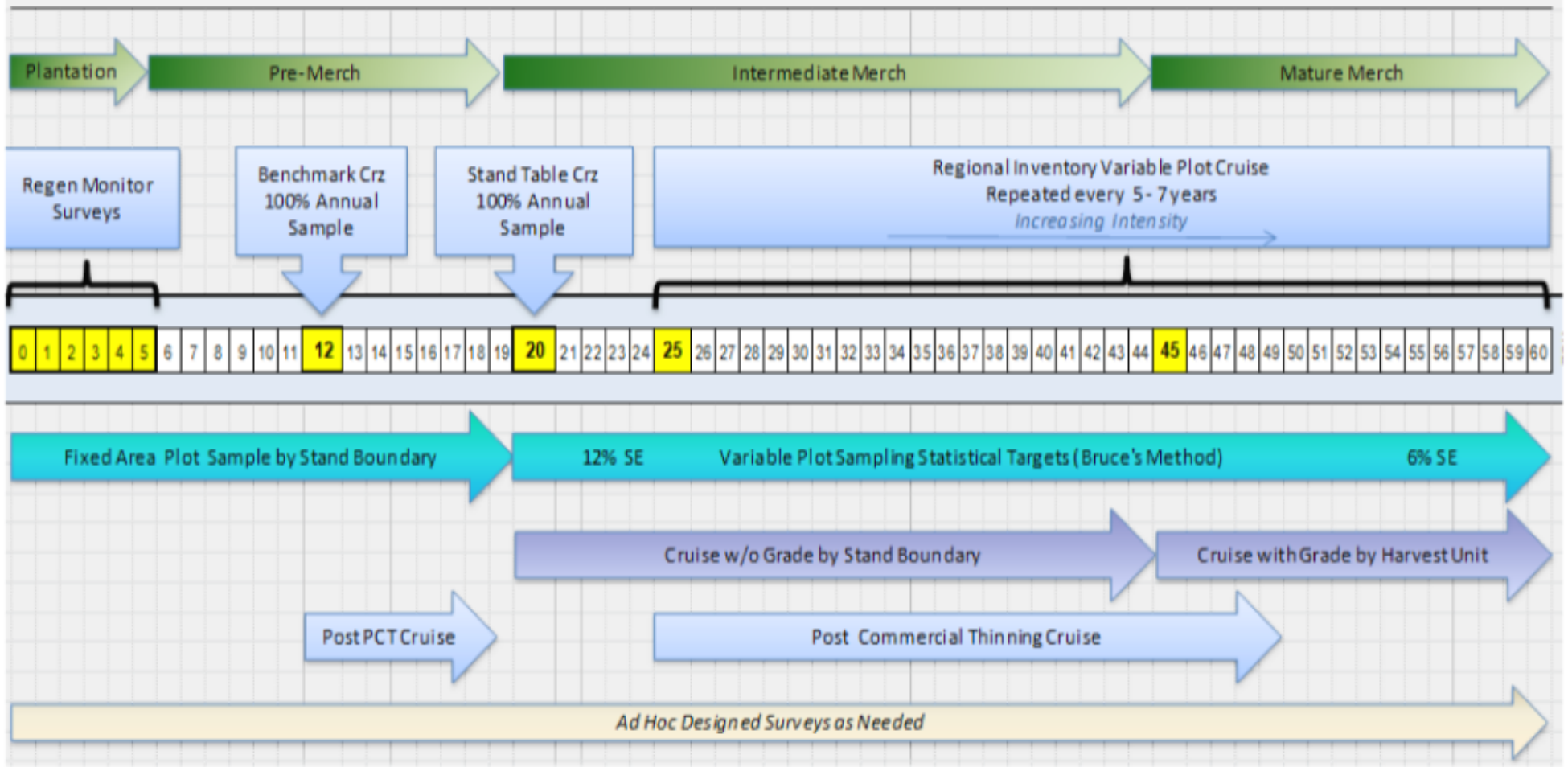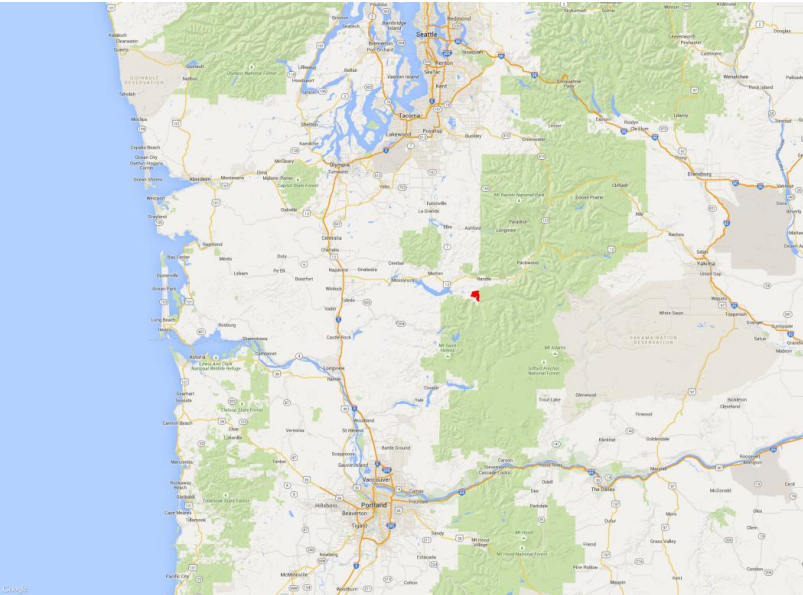
- 34 stands
- 1775 acres
- Age 26 to 84 (mean of 53)

Plot data

Radar + Spectral

LiDAR

Past Inventory

Report

Stand Level:		
BA		
TPA		
Total Volume		
QMD		
Total Height		
Height to Live Crown		
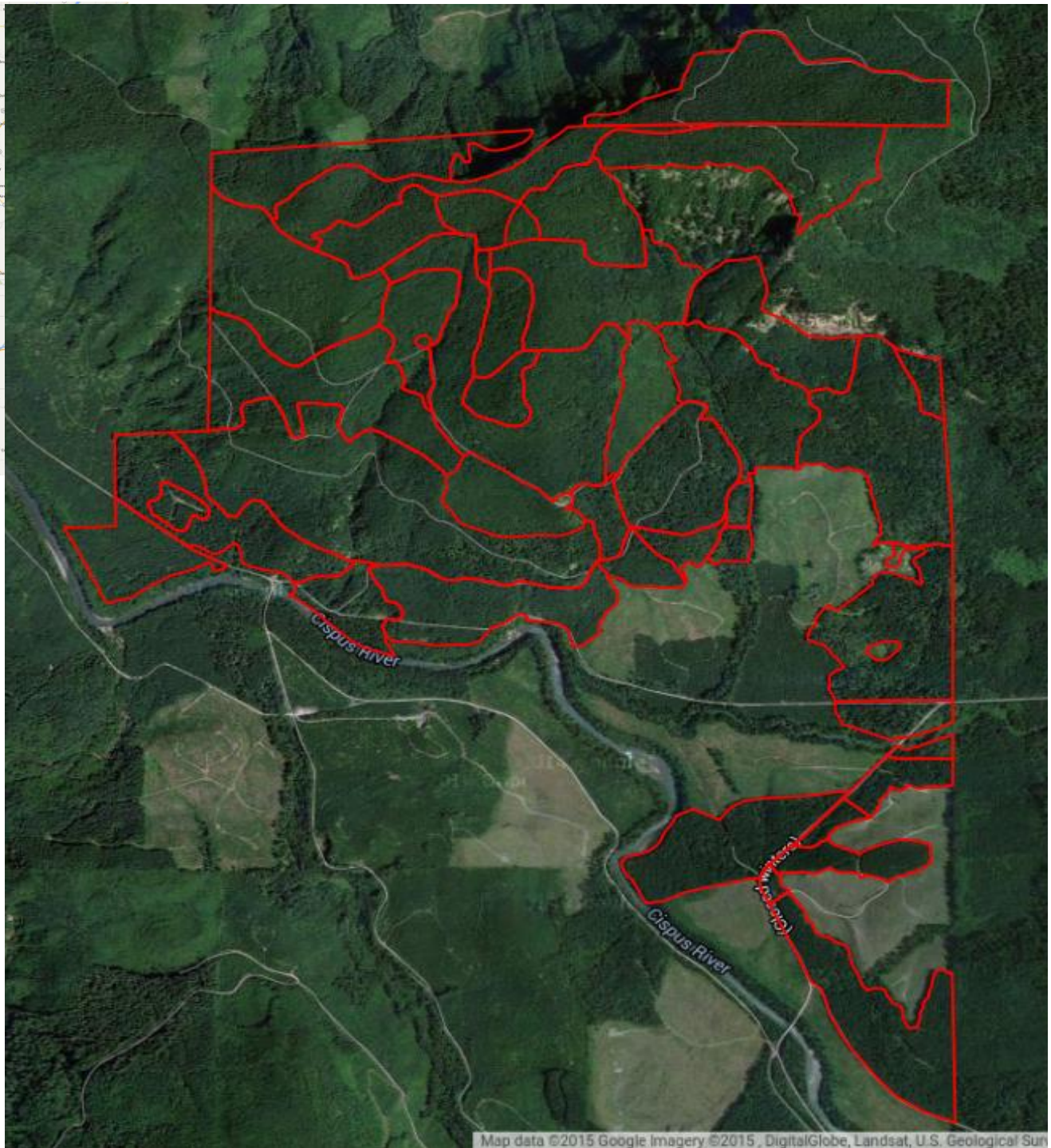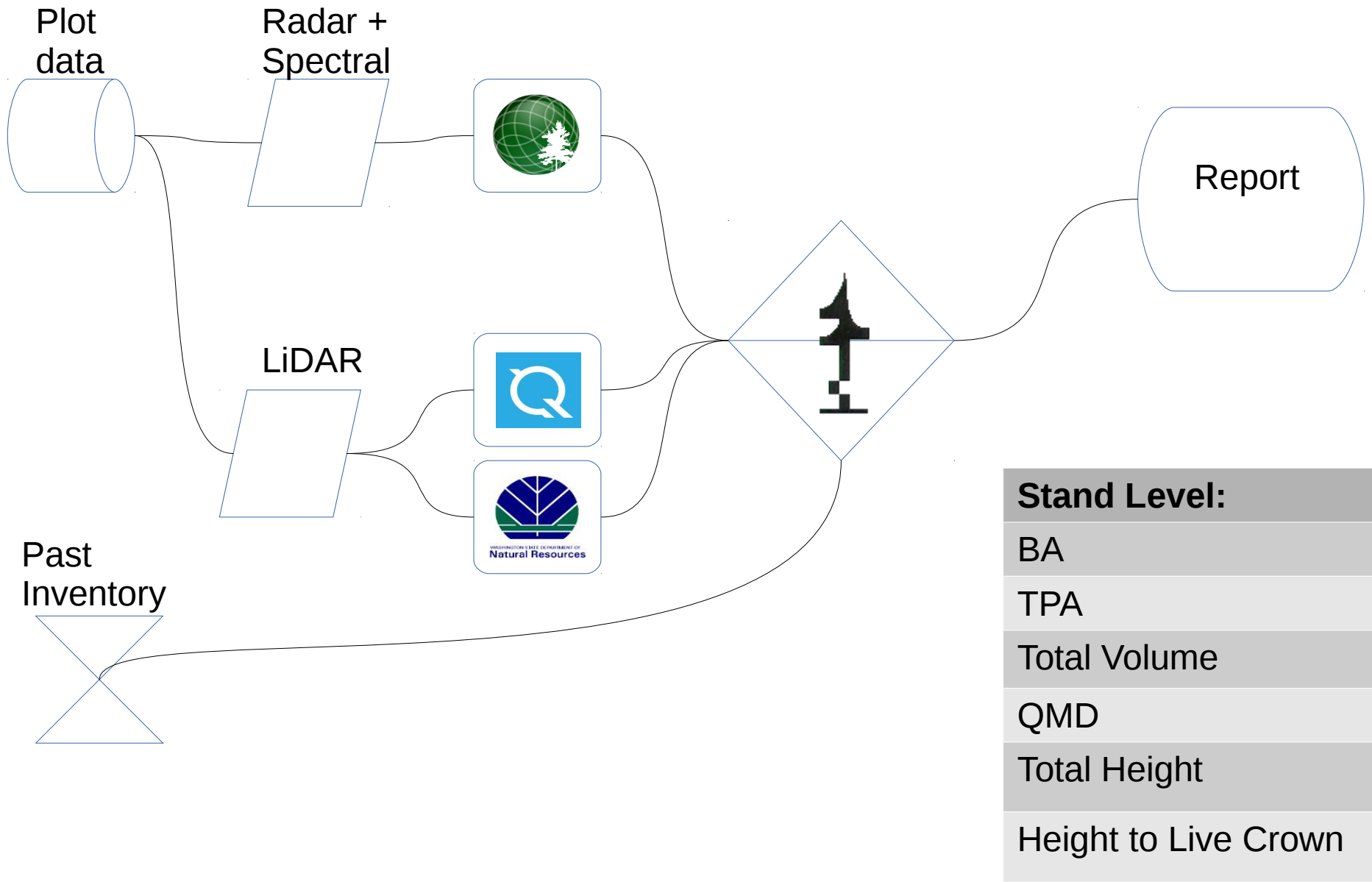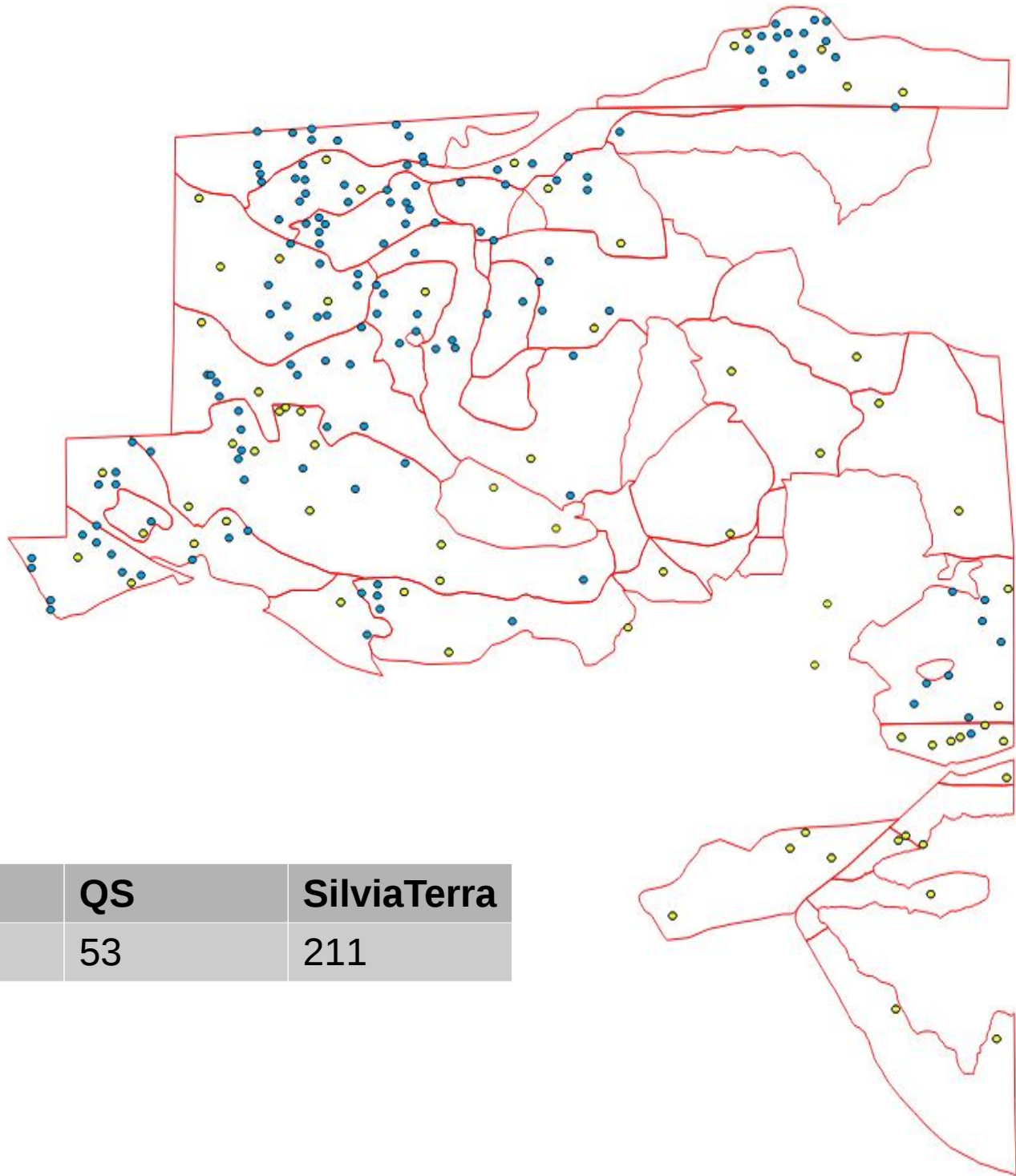
PBTF	DNR	QS	SilviaTerra
874	70	53	211

The processes used
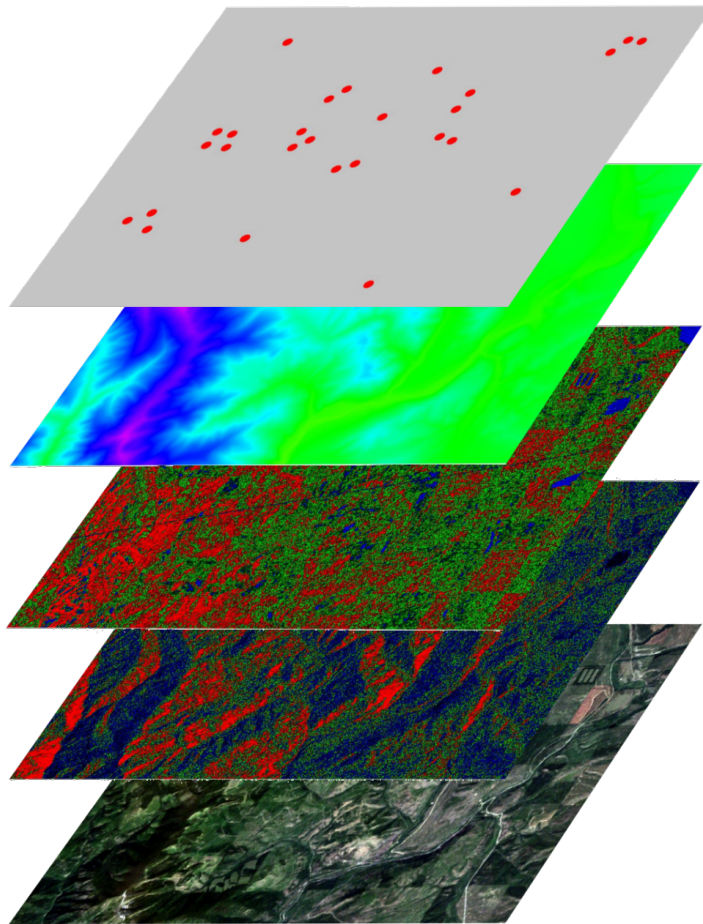
- Impute TL from plots to pixels

- Model / Predict aggregate statistics

- **Model multiple parameters combine and predict all, resolve to TL.**

A few expectations going in

- LiDAR (light) v. Radar (radio)

- This was set up as a Design Based approach and that has some baggage.

- All were area based predictions (no ITC)
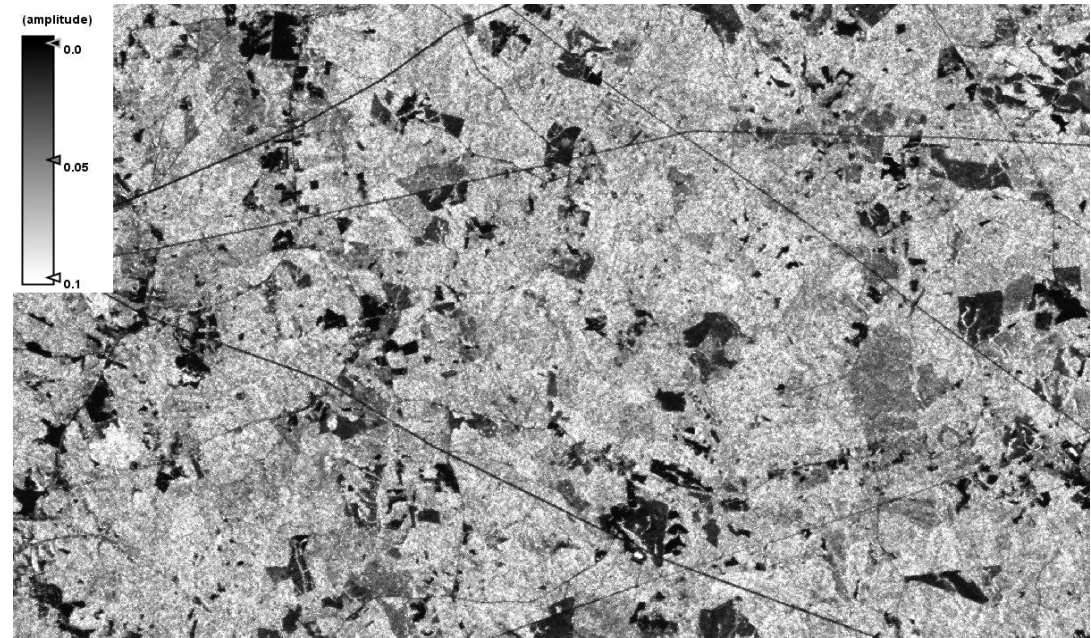
Forest Level Comparison

	Best	Middle	Lowest
<u>Volume</u>	DNR (97%)	QS (88%)	ST(85%)
Ht to Crown	QS (99%)	ST (90%)	-
<u>Total Height</u>	ST (97%)	QS (88%)	DNR (117%)
Quadratic Diameter	QS (92%)	DNR (91%)*	ST (85%)
<u>Basal Area</u>	ST (98%)	DNR (93%)	QS (92%)
Trees / Acre	QS (102%)	DNR (104%)	ST (128%)

"In my opinion, the underlined items are perhaps the most critical. In these, ST would have been the best in each of the 3 categories (as a forest average) if their tree form factor had been correct. I have made no comparisons by species.

The weakness in the Silvia Terra results is estimating the individual stand values, over which these overall values might be dispersed with some uses of the method.
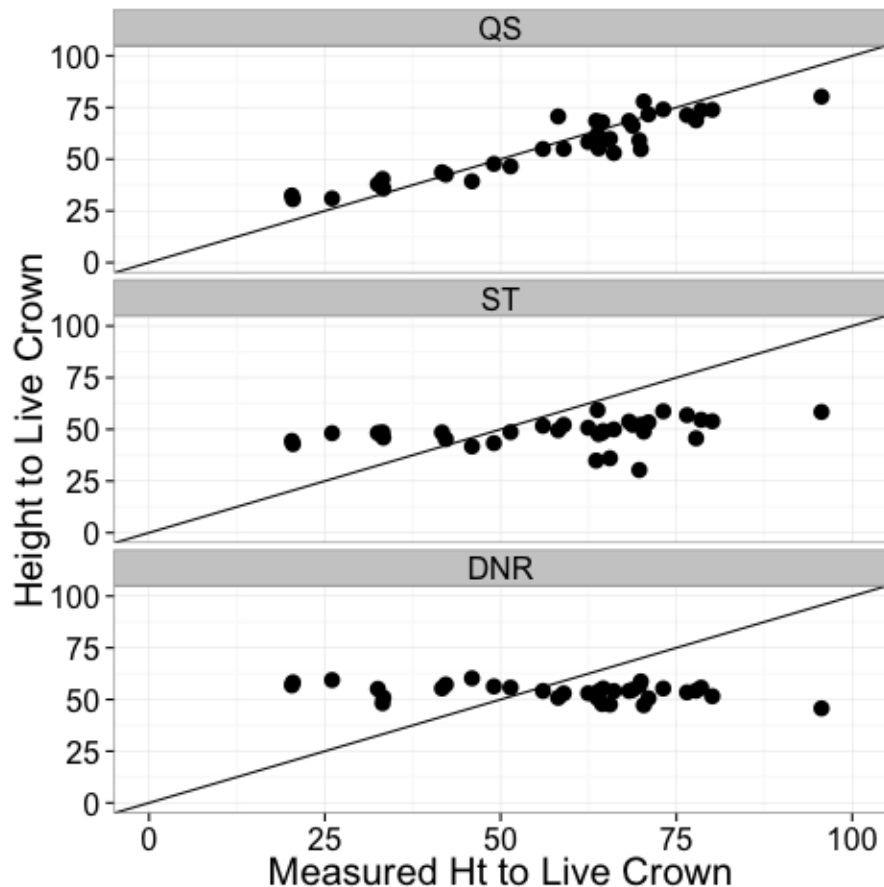
The QS and DNR methods were similar, and generally better at discriminating individual stands."

Stand Level Total Volume
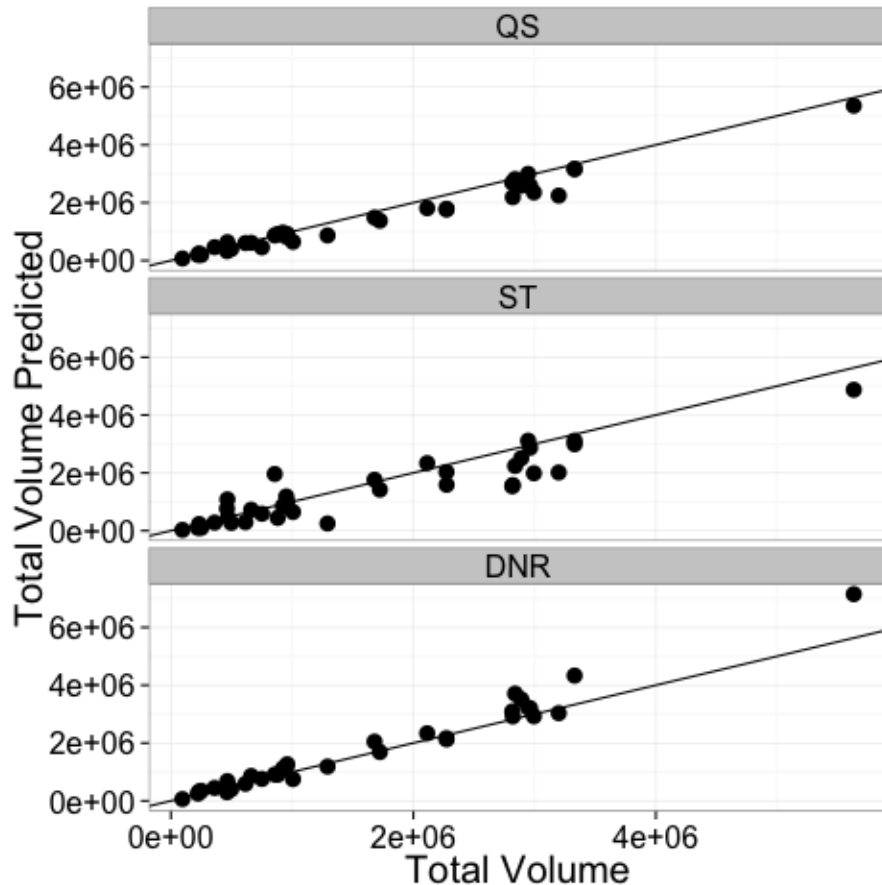
- QS: (88%) de-emphasizes errors in small stands

- ST: (85%) Variability is greater in most stand sizes

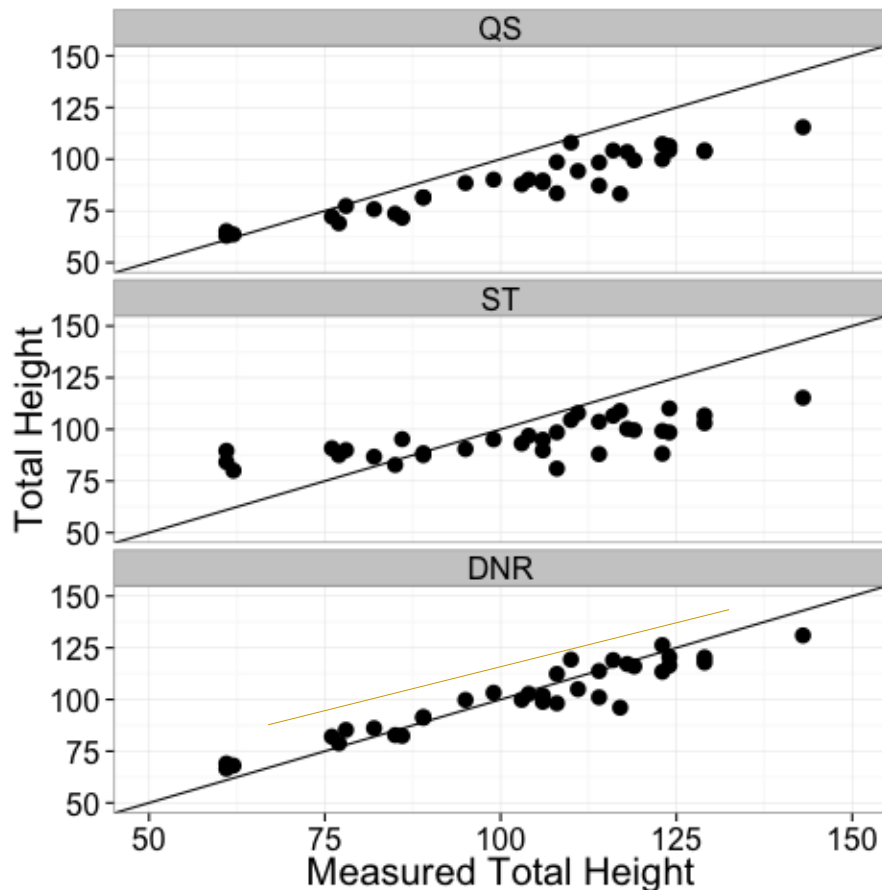- DNR: (97%) and a good fit to the relative stand total volumes

Stand Level Ht. to Live Crown

- QS: (99% correct overall) Height to Crown Base for stands

- ST: (90%) too "flat" a fit to the actual data.

- DNR: (*) *not available in original submisison.*

* from corrected numbers – I suspect a problem in the hand off.

Stand Level Total Height

- QS: (88%) The heights were low, and slightly "flatter" than the comparison data.

- ST: (97%) is right on for average height, but does not distinguish as well between stands. With a better overall fit , it might estimate well, and is the most accurate overall average without any correction to the process.

- DNR: (117%) heights were too high, and fairly variable even if corrected.**
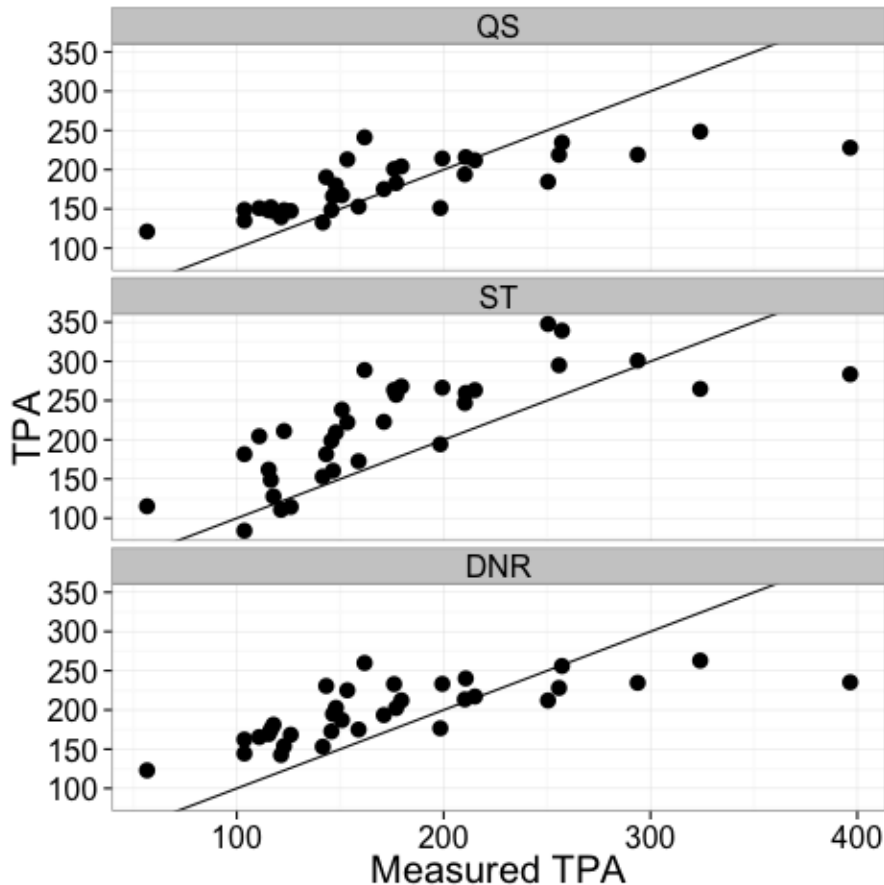
** corrections provided by DNR

Stand Level QMD
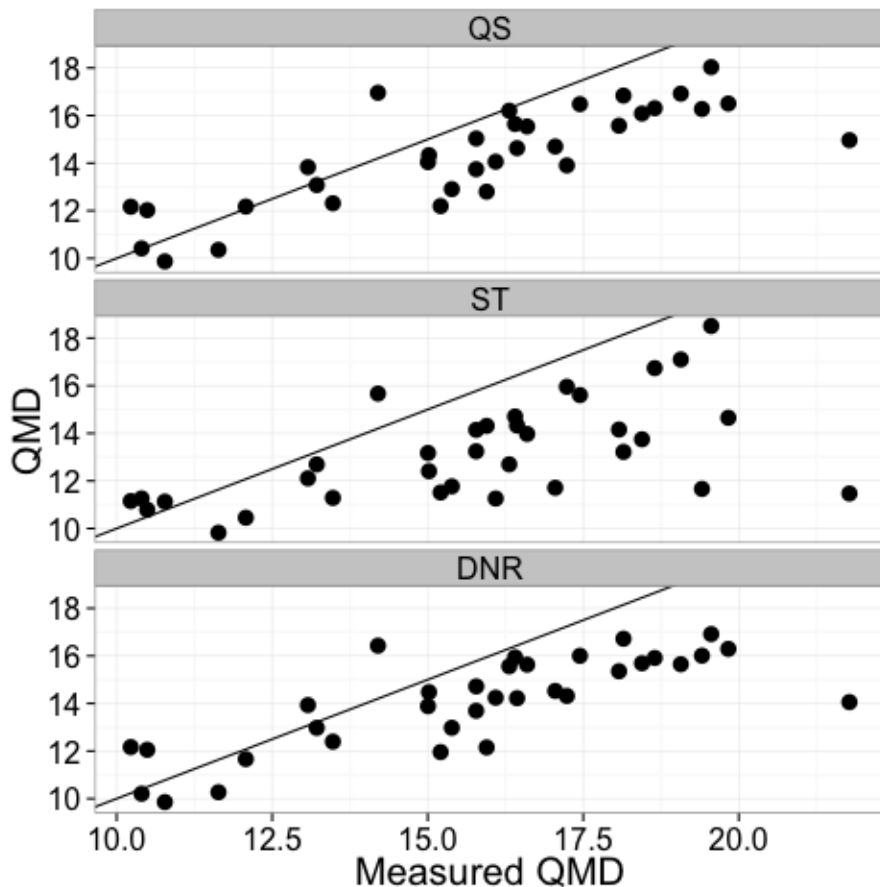
- QS (92%) a bit low, but has pretty good relative discrimination around any fitted line.

- ST (85%) is pretty variable in this case, and low as well

- DNR(91%*) estimates are a bit too "flat" compared to others, and clearly low. Even an overall upward correction will not solve the problem.

Stand Level TPA

- QS: (102%) Not a particularly good fit for individual stands

- ST: (128%) High overall, and with a curved fit to the actutal PB data.

- DNR: (104%) the fit is too "flat", essentially calling all stands much the same value.

Stand Level Basal Area
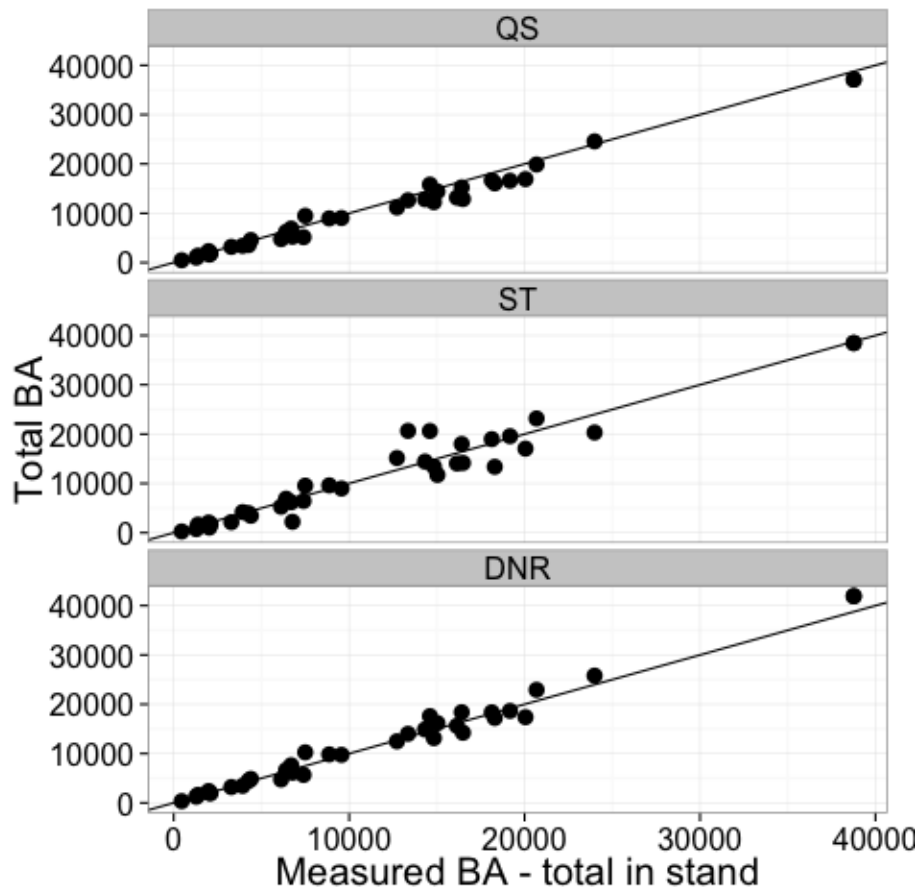
- QS: (92%) a bit low, on average, and "too flat", but a pretty good job by stand.

- ST: (98%) A good *overall* average but scattered and not good for individual stands.

- DNR (93%) Not bad as a total, and a pretty good job by stand.

So, was this case "good"?

- Is it credible?
  - Radar and LiDAR are credible predictors
  - Not in this state. Neither the LiDAR nor Radar methods produced confidence inspiring predictions.

- Is it complete?
  - Does not address grade / defect / product.

- Is it more efficient and / or provide more nuanced information?
  - $?

Getting to Credible and Complete

Using model assisted estimators

- Avoids dependence on a blackbox
- Bias correction term
- Deals with grade / defect / product
- Has a safety net.
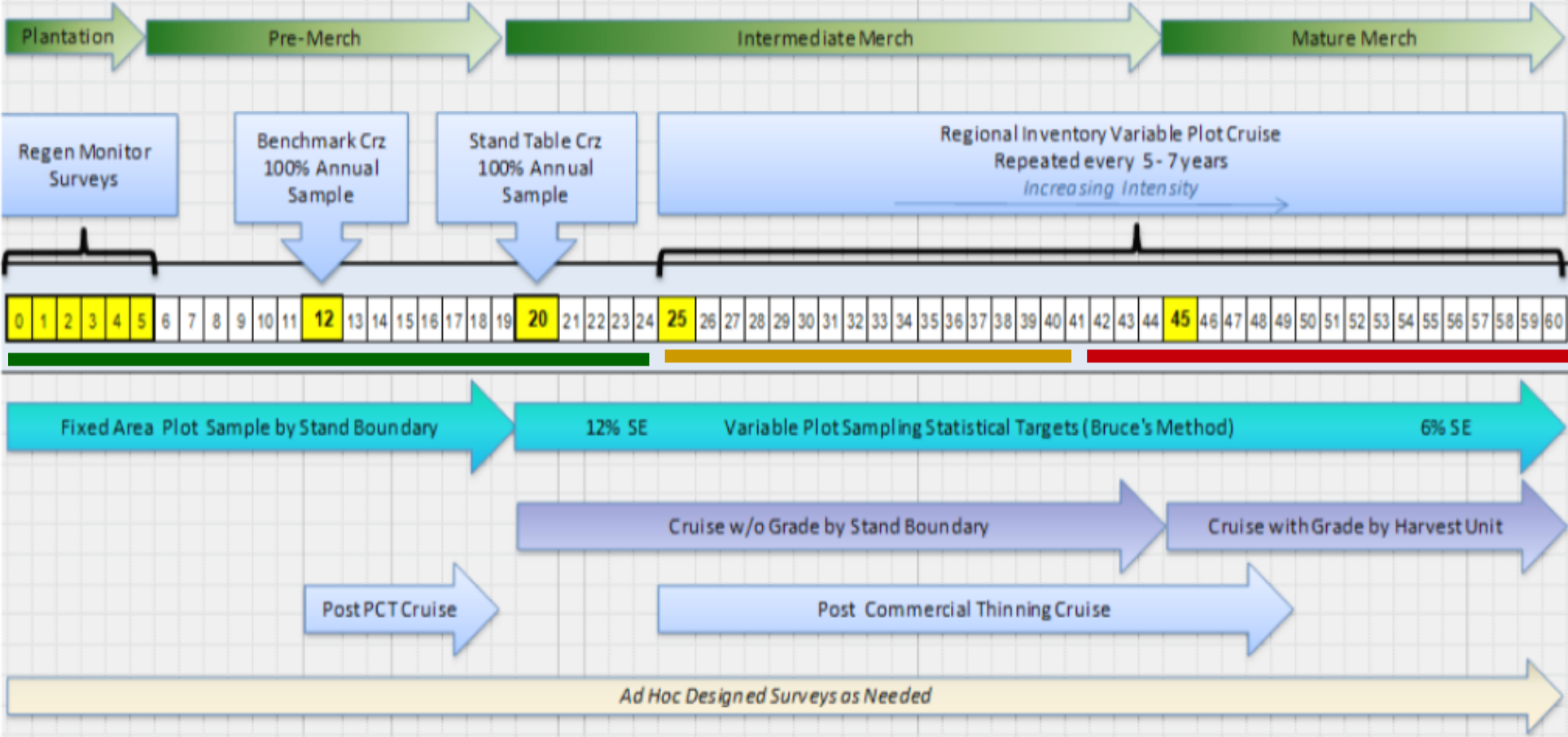- Transition to design based as ready made test cases indicate is useful.

In practice

GPS your plots well

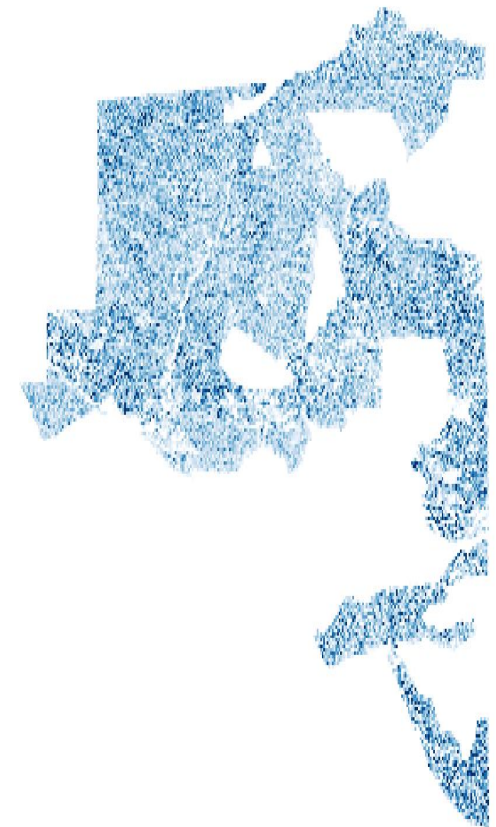Be judicious when selecting auxiliary information

(re-) Consider VRP

PBTF Forest Inventory Sampling Plan *Revised 11/14/11*

Optimism and Pragmatism

No panacea, but there are options that are ready for application.

Thanks to

- **Port Blakely**
  - Chris Lacey
  - Mike Mosman
  - Ryan Parker
  - Eric Cohen
- **WADNR**
  - Peter Gould
  - Jacob Strunk

- **Quantum Spatial**
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- **SilviaTerra**
  - Nan Pond
  - Nathan Rutenbeck
- **Kim Iles**