Use of active satellite remote sensing to estimate biomass/carbon: An (Alaska) FIA perspective

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Forest Inventory and Analysis

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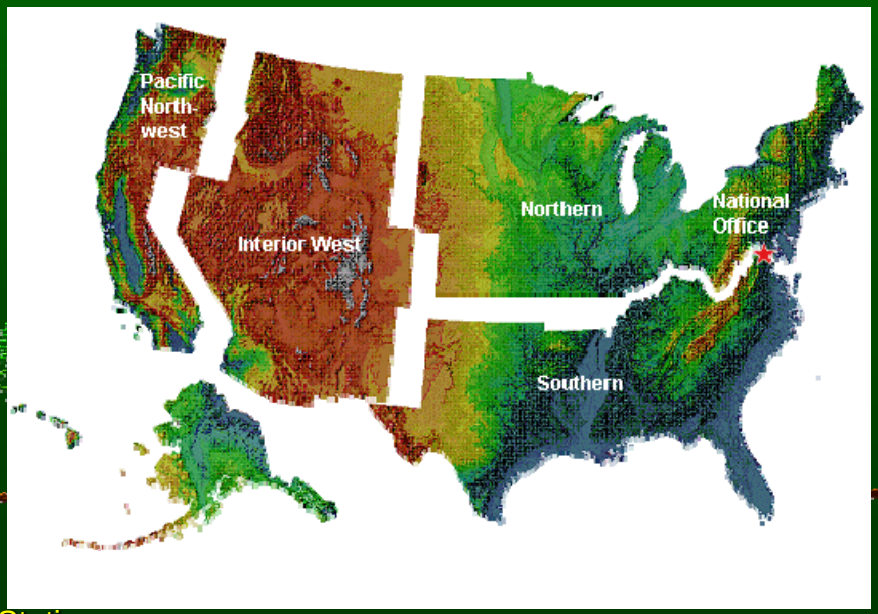
The Forest Inventory and Analysis (FIA) program

The forest inventory program for the U.S. (FIA) – 1998 major revision

- ***"Annual" inventory (measurements taken everywhere every year)***
- ***All forest land (public and private)***
- ***Single plot design***
- ***National database & software programs***
- ***Forest (not just timber) inventory***



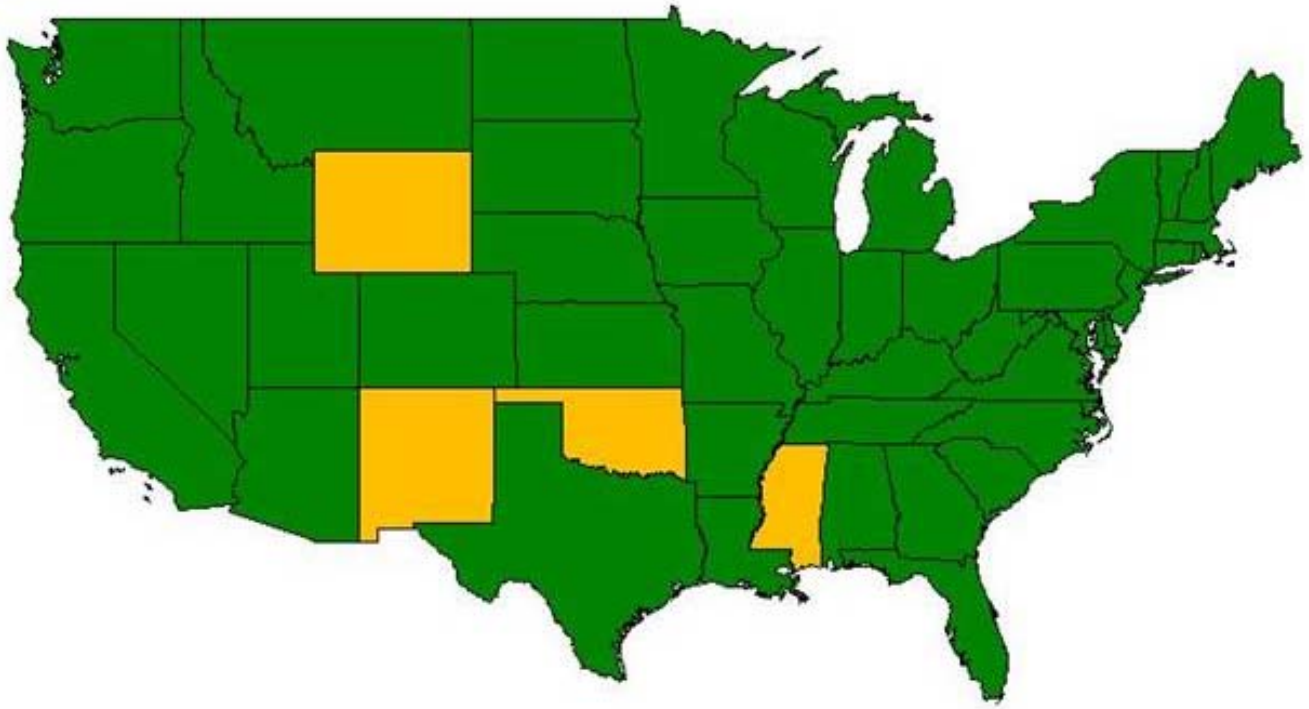
2007 annual inventory status

Funding is at about 87% of 1998 target

44 states implemented

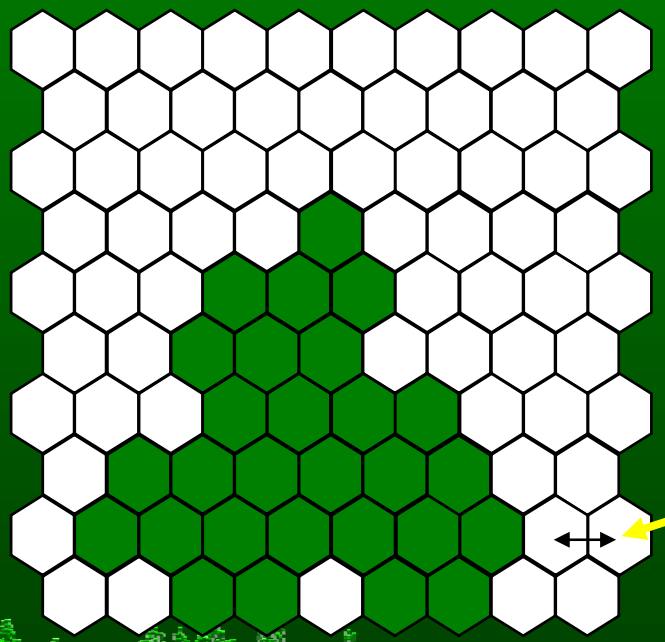
5 not: Hawaii, Wyoming, New Mexico, Oklahoma, and Mississippi

1 partially implemented: Alaska



FIA sampling frame

FIA sampling frame



Forest/nonforest stratification (Phase 1)

FIA hexagon (Phase 2)

3.27 mi

Phase 3: Additional (forest health indicator) measurements acquired on 1/16 sample of Phase 2 plots

FIA inventory design

Phase 1

Plot

Forest/Nonforest

Phase 2

Plot

Reserve status
Owner
Forest type
Stand age
Stand size
Stand origin
Site class
Slope
Aspect
Stocking

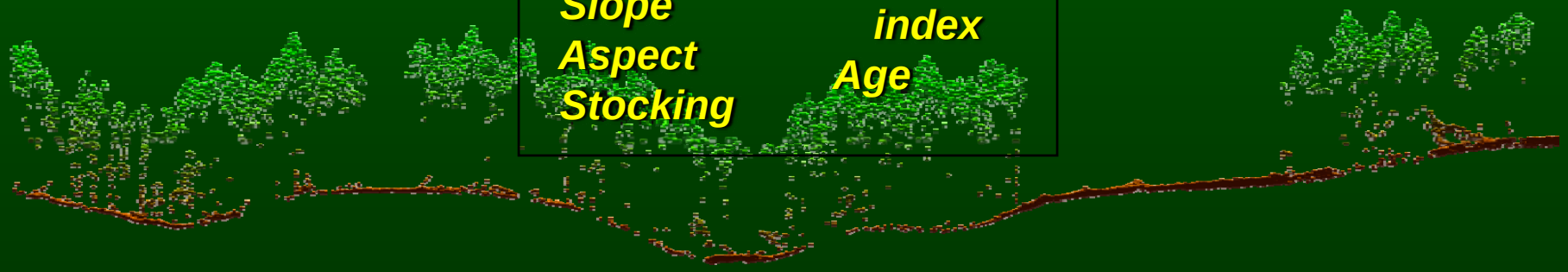
Tree

Species
Height
DBH
Damage
Azimuth/ Distance
Defect
Site index
Age

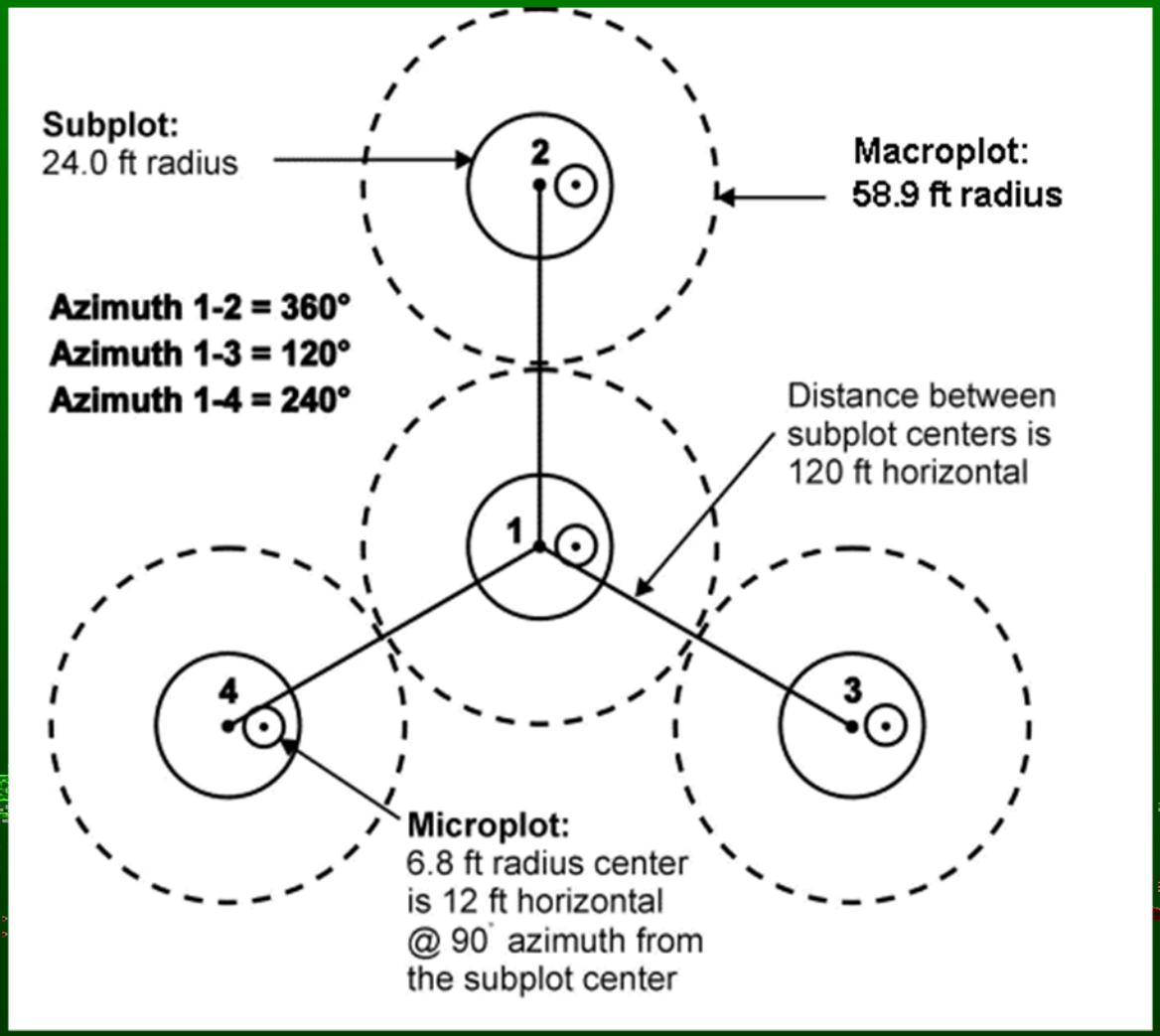
Phase 3

Plot

Lichens
Understory vegetation
Down Woody Debris
Ozone damage
Crown condition
Soils



FIA field plot design



FIA data availability

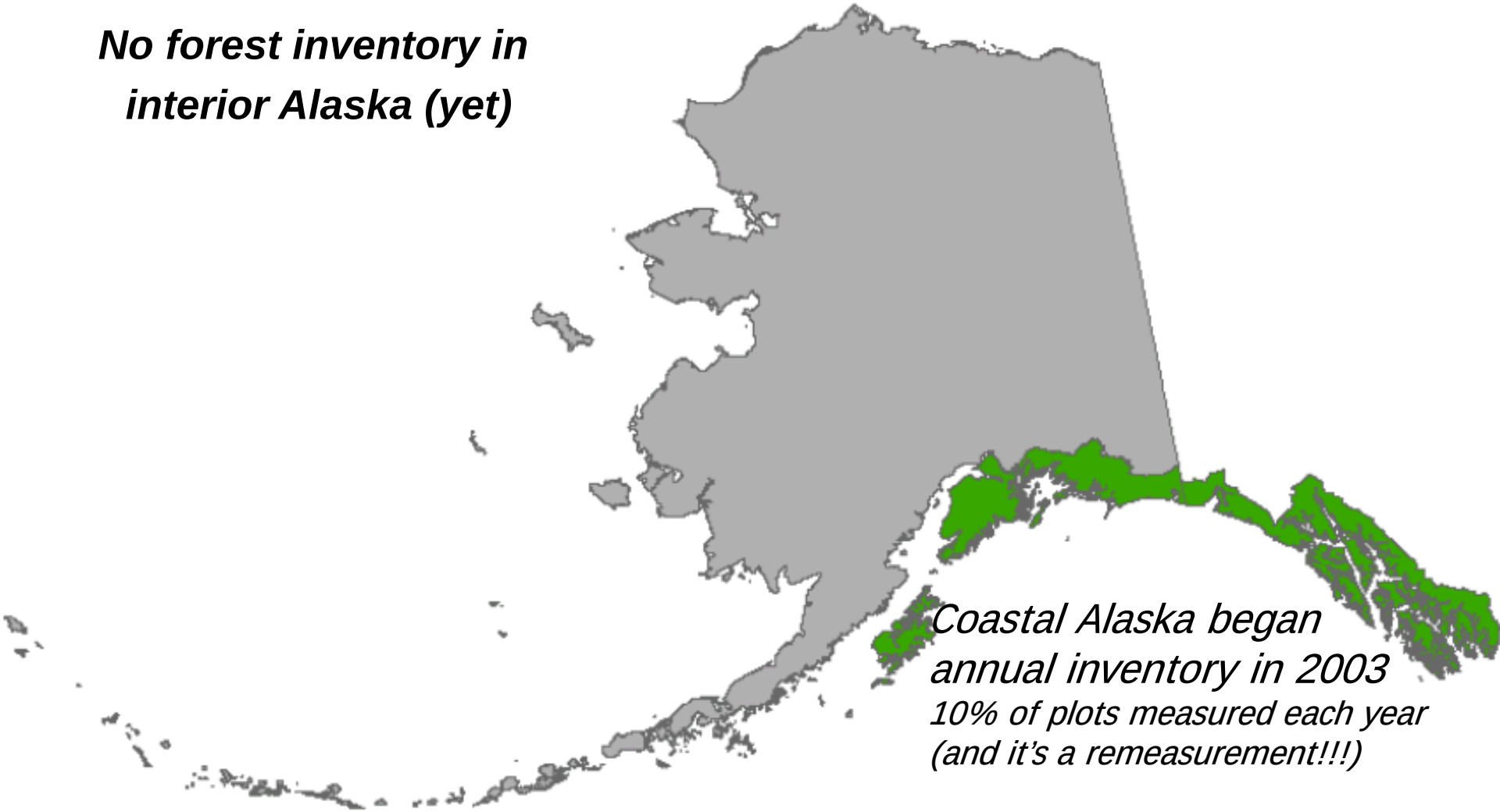
Standardized, spatially-extensive data characterizing forest type and condition over (almost) entire US

FIA data is available online:
(http://fiatools.fs.fed.us/fiadb-downloads/fiadb3.html)

"Precise" plot coordinates available for research projects (need MOU with USFS to protect plot confidentiality)

Status of FIA inventory in Alaska

No forest inventory in interior Alaska (yet)



Coastal Alaska began annual inventory in 2003

10% of plots measured each year (and it's a remeasurement!!!)

Status of FIA inventory in Alaska Boreal Forests

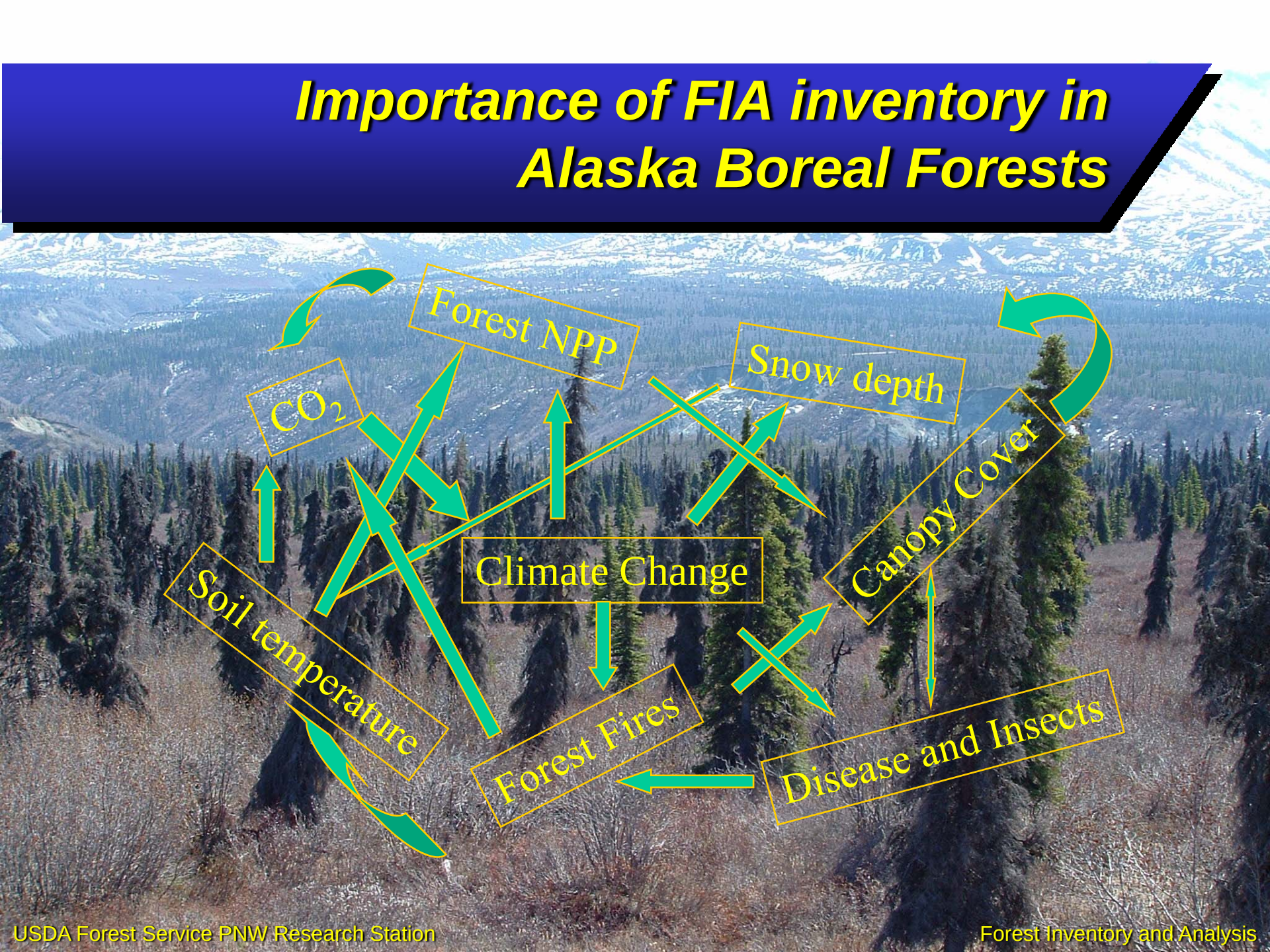
We estimate that Alaska has 17% of U.S forest land, almost 4% of the world's forests.

Roughly 112 million acres of forest in "interior" Alaska.

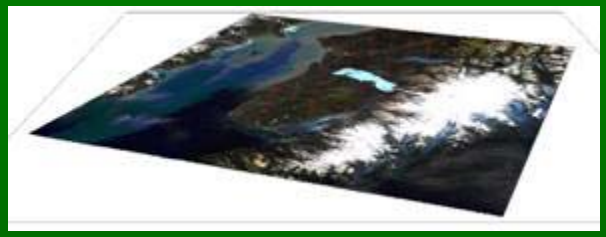
- ✓ Vast
- ✓ Mostly low site
- ✓ Inaccessible
- ✓ Difficult and expensive to inventory

Cost of helicopter-access plots on Kenai Peninsula, AK: ~ $6000/plot

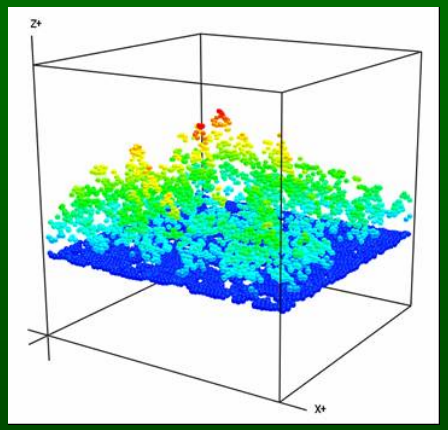
Importance of FIA inventory in Alaska Boreal Forests



Multi-level Approach to Estimating Biomass/Carbon in Alaskan Boreal Forests



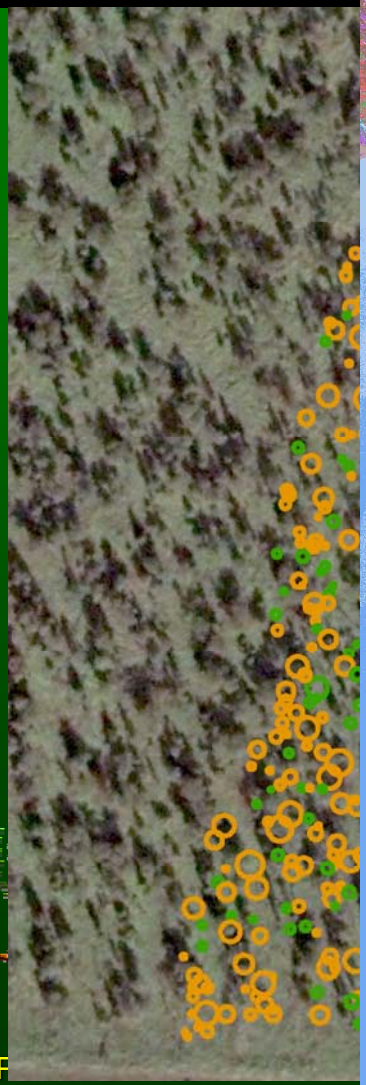
Top-level: Satellite RS (e.g. ICESAT, Landsat TM, MODIS, DESDynI?)

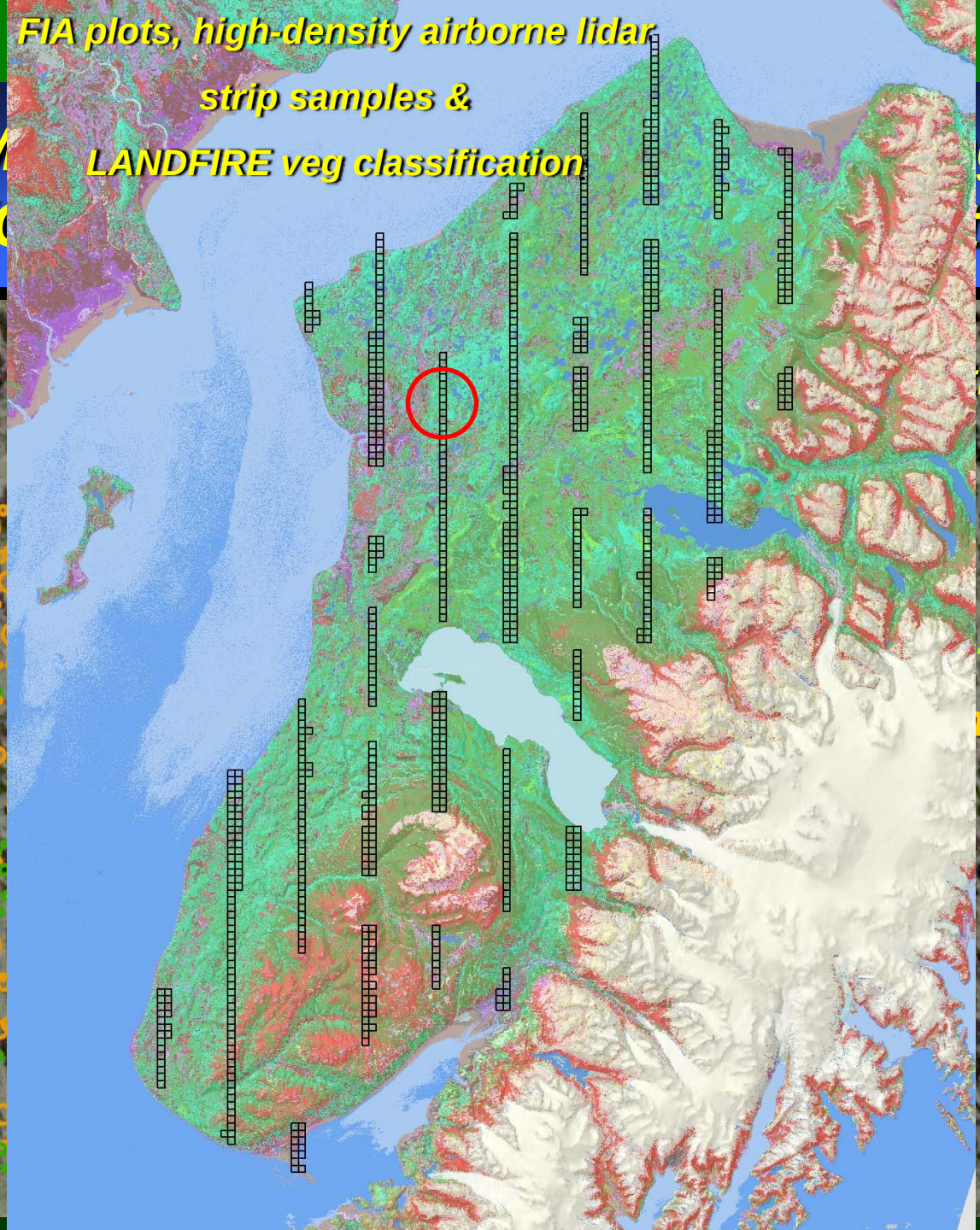


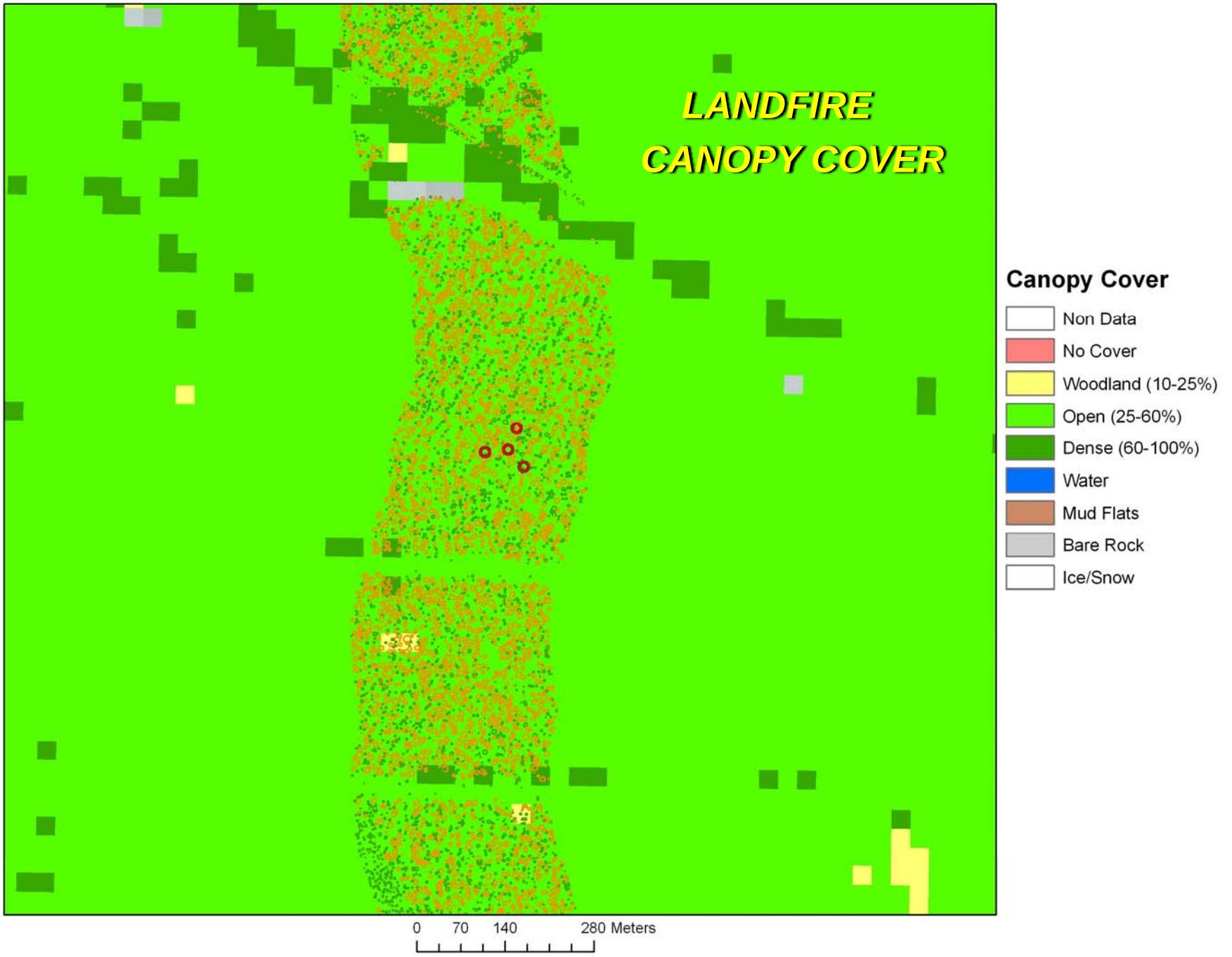
Mid-level: High-res airborne lidar

Low-level: Field data

FIA plots, high-density airborne lidar strip samples & LANDFIRE veg classification






LANDFIRE
CANOPY COVER
Canopy Cover
Non Data
No Cover
Woodland (10-25%)
Open (25-60%)
Dense (60-100%)
Water
Mud Flats
Bare Rock
Ice/Snow
0 70 140 280 Meters

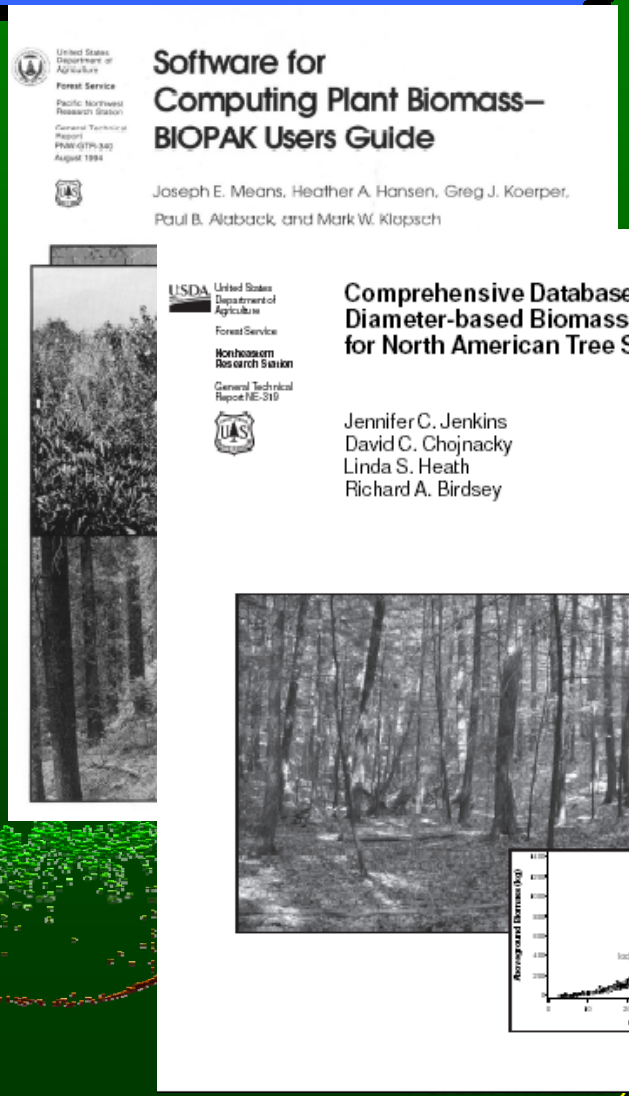
Estimating Biomass in North American Forests

We have several compilations of diameter-based biomass regression models for North American species:

- ***Means et al., 1994, Software for computing plant biomass – BIOPAK users guide, USDA Forest Service General Technical Report-PNW-340***

- ***Jenkins et al., 2004, Comprehensive Database of Diameter-based Biomass Regressions for North American Tree Species, USDA Forest Service General Technical Report-NE-319)***

Most equations are site-specific



Estimating Biomass in North American Forests

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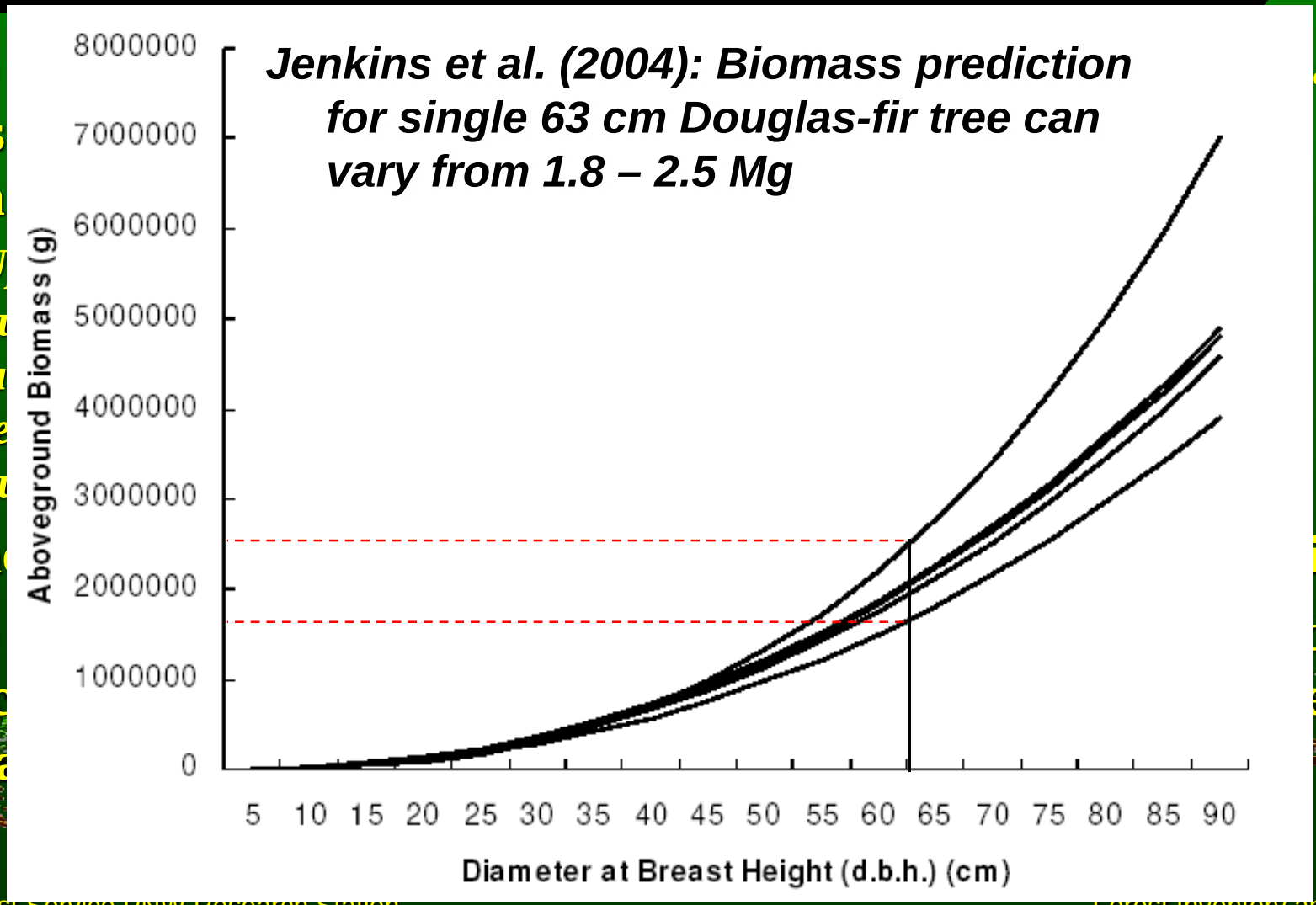

Remotely–sensed metrics that are highly correlated with biomass

1) CANOPY HEIGHT

ICESat canopy height (Lefsky et al., 2005, Geophys. Res. Letters 32)

SRTM C-band canopy height + environmental vars. (Kellndorfer et al., 2006, IGARS06)

Airborne profiling lidar (Nelson et al., 2005 Scan. J. For. Res.)

2) CANOPY HEIGHT, CANOPY COVER

SLICER canopy cover & mean canopy height (Lefsky et al., 2001, ISPRS-Annapolis)

PNW-FIA Anchorage is developing cover/ht vs. biomass models for several AK forest types

3) CANOPY HEIGHT, CANOPY COVER, VERTICAL STRUCTURE

Mean height, canopy cover, and coefficient of variation in canopy height are primary lidar-based biomass predictors for sites in CA, WA and AK (Li et al., West. J. App. For., in press)

4) POLARIMETRIC SAR BACKSCATTER

P- and L-band polarimetric SAR measurements correlated with biomass at boreal forest site (Saatchi and Moghaddam, IEEE Trans. Geoscience & Rem. Sens. 2000)

Other considerations…

1) SAMPLING INTENSITY

- ***Relation to spatial variability in cover/height/structure across landscape – mapping tool or statistical sampling tool?***

2) REVISIT TIMES

- ***Years, not months***

3) HEIGHT MEASUREMENT ACCURACY

- ***Precise height measurements are required to capture relatively narrow range of height variability in AK boreal forests (0 – 25 meters)***

4) NEED FOR CONTINUOUS PROFILES

- ***Continuous profiles allow for characterizing structural variability across a wide range of spatial scales, more precise canopy cover estimates (see #1)***

5) NEED FOR WAVEFORM DATA VS. FIRST/LAST RETURN

- ***Waveform data needed to characterize 3-D canopy structure & depth***

Questions/Discussion?