Forest Inventory and Analysis (FIA):

Regional Monitoring of Habitat Change Through Sampling Forest Vegetation

Tara Barrett, Research Forester
Anchorage, Alaska

Andrew Gray, Research Ecologist
Corvallis, Oregon

Pacific Northwest Research Station
USDA Forest Service

Outline for talk

1. Forest Inventory and Analysis (FIA) – an example of a regional/national monitoring program

2. FIA – how we got here and the lessons learned

3. Examples of analysis: The bread & butter, the cool, and the slightly scary uses of FIA data

FIA purpose: monitor and assess forests of the U.S.

Western hemlock forest near Hawk Mine, Alaska, 7/21/2007

Monitored attributes - possible climate change impacts

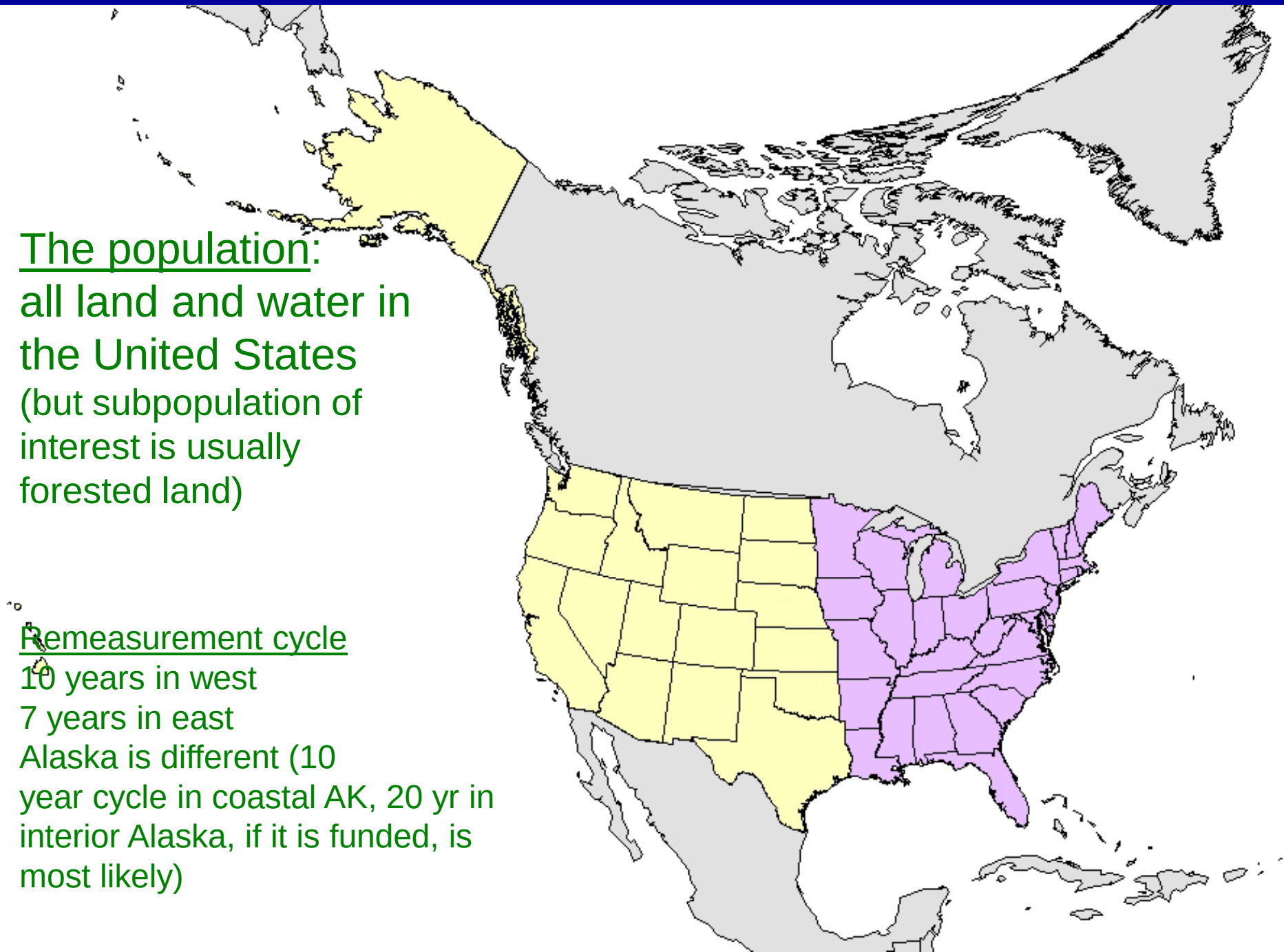
- distribution of tree species
- mortality of trees
- regeneration of trees
- growth of trees
- stand structure, age, and composition
- understory plant diversity (1/16 subsample)
- vegetation cover by lifeform (1/16 subsample)
- change from forest to nonforest and vice-versa
- biomass and carbon of above-ground forest veg
- down woody debris (1/16 subsample)
- crown condition (1/16th subsample)
- soil composition and structure (1/16 subsample)
- lichen diversity (1/16 subsample)

Monitored attributes - possible direct human causes

- invasive plants
- harvest and utilization of timber
- other direct human-caused mortality (e.g. firewood cutting)
- deforestation (conversion of forest to developed or ag lands)
- ozone damage to vegetation (special plot network)

Monitored attributes - natural disturbance causes

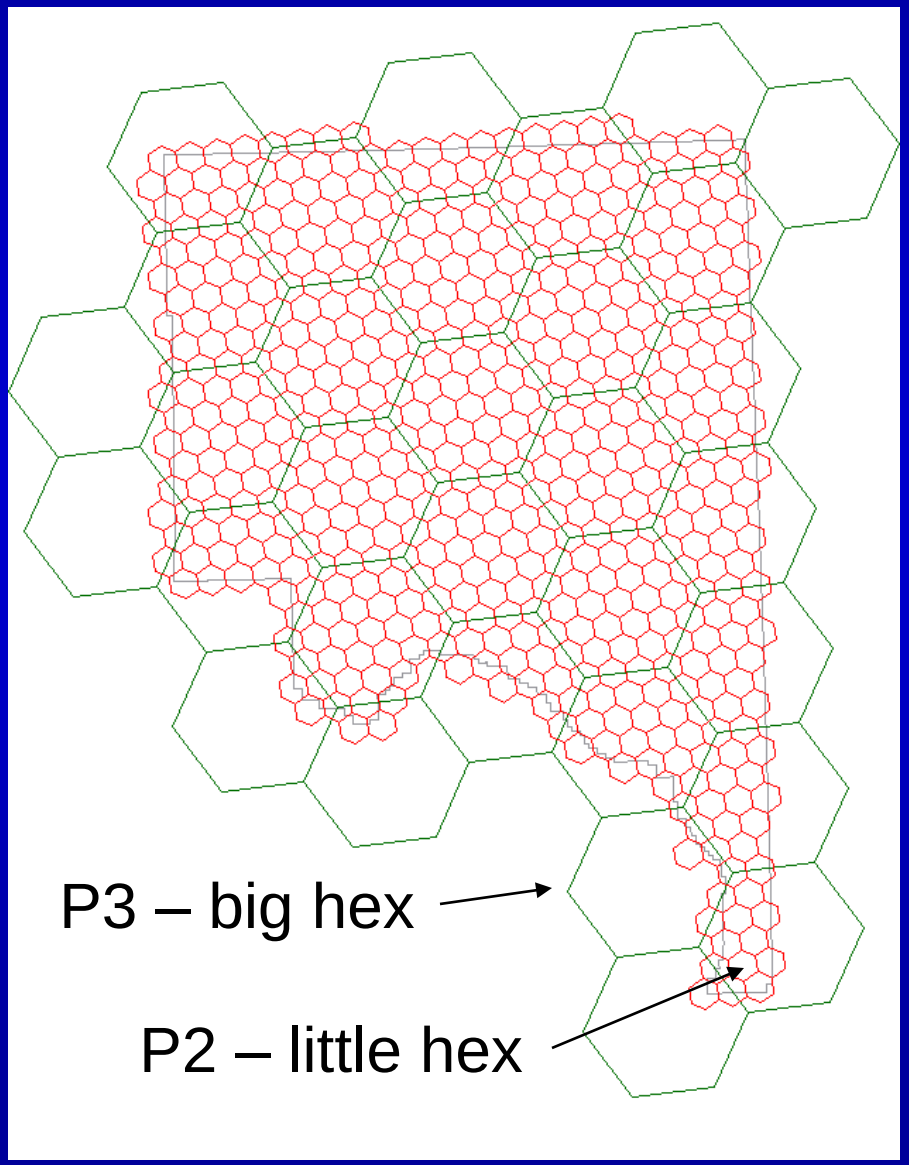
- pre-fire risk, post-fire fire effects, post-fire succession
- tree mortality from a variety of causes ranging from windthrow, to volcanos
- presence and damage of a variety of insects and pathogens (e.g., bark beetles, defoliators, root and heart rots) (not in AK at present)



The population:
all land and water in the United States
(but subpopulation of interest is usually forested land)

Remeasurement cycle
10 years in west
7 years in east
Alaska is different (10 year cycle in coastal AK, 20 yr in interior Alaska, if it is funded, is most likely)

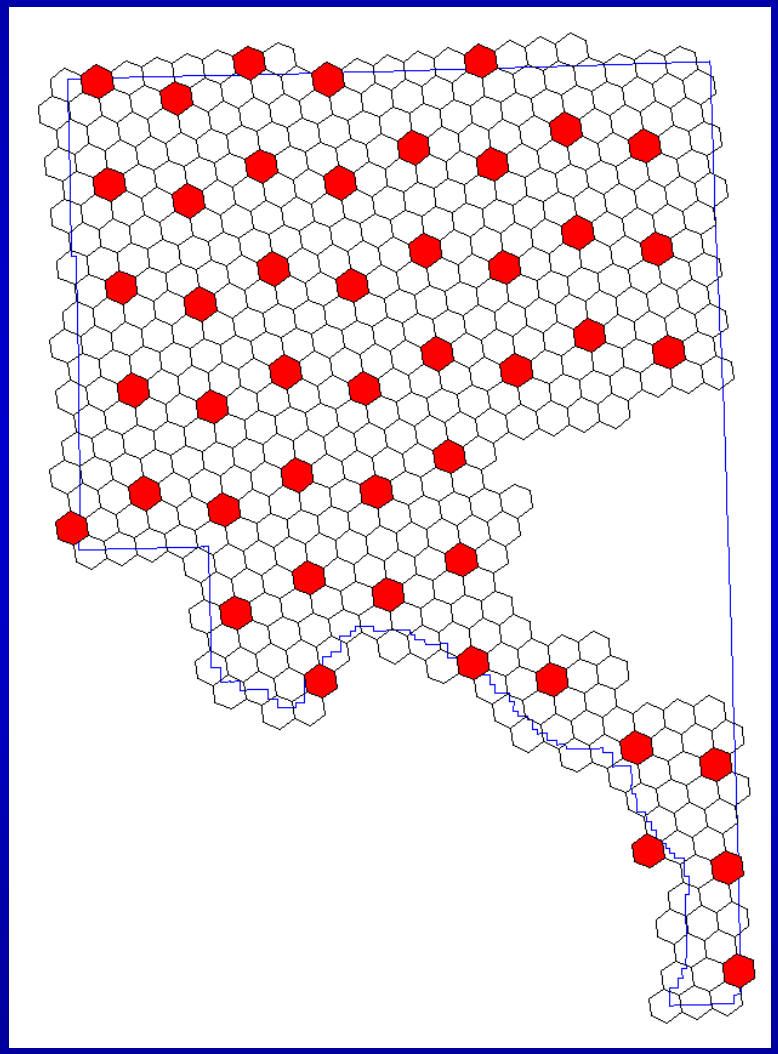
•The sample unit: a point (in space and in time), with measurements taken on a plot surrounding the point.



Equal probability sample, systematic with a random component:

- P3 hexes: Tessellation of about 26,000 hexes across US
- Each P3 hex is subdivided into 16 smaller P2 hexes
- About 420,000 P2 hexes used for sample selection

‘Annual’ FIA

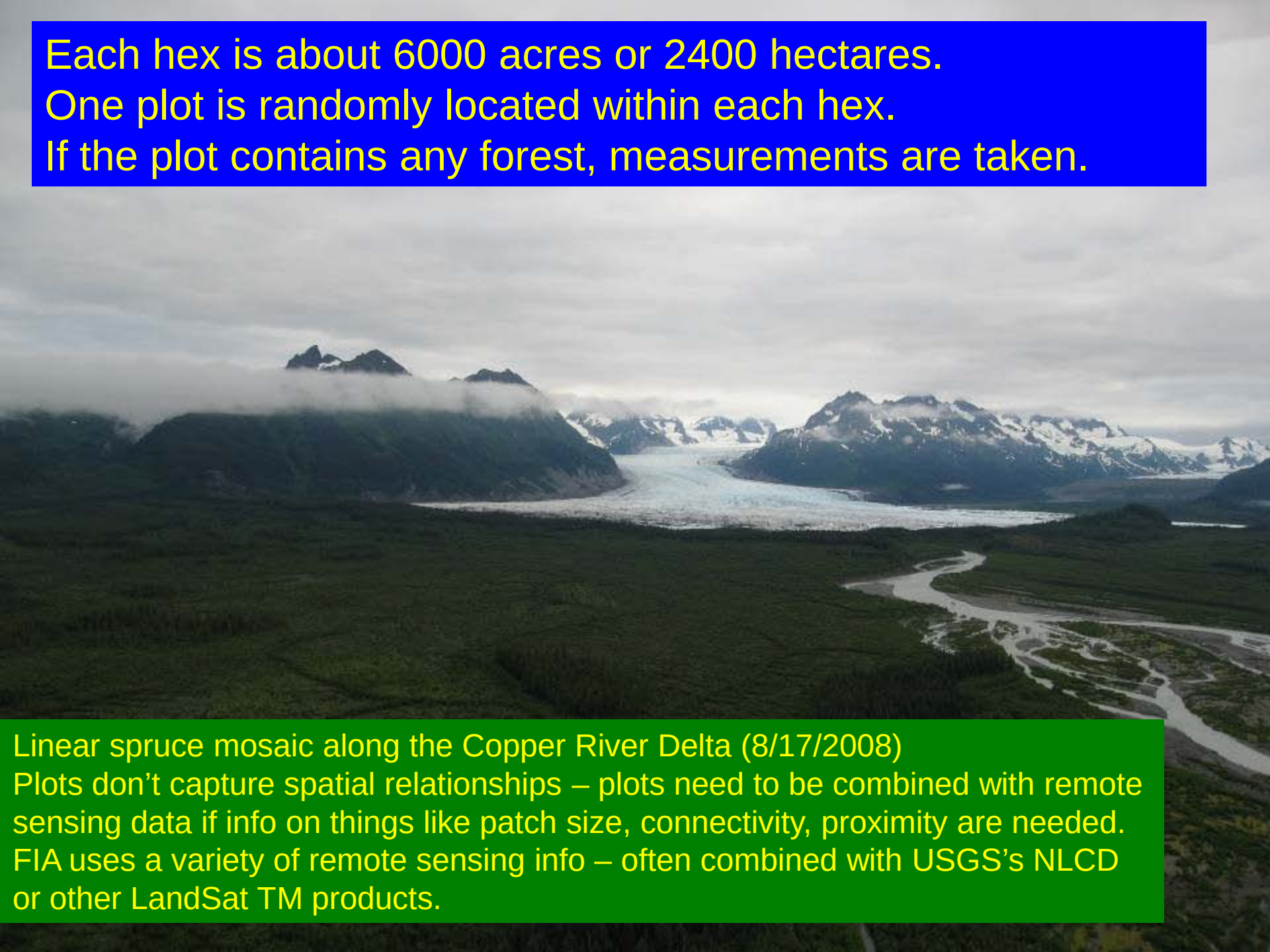


In coastal Alaska, FIA uses a10 year remeasurement cycle

Every year, 1/10th of all plots (a “panel”) are measured.

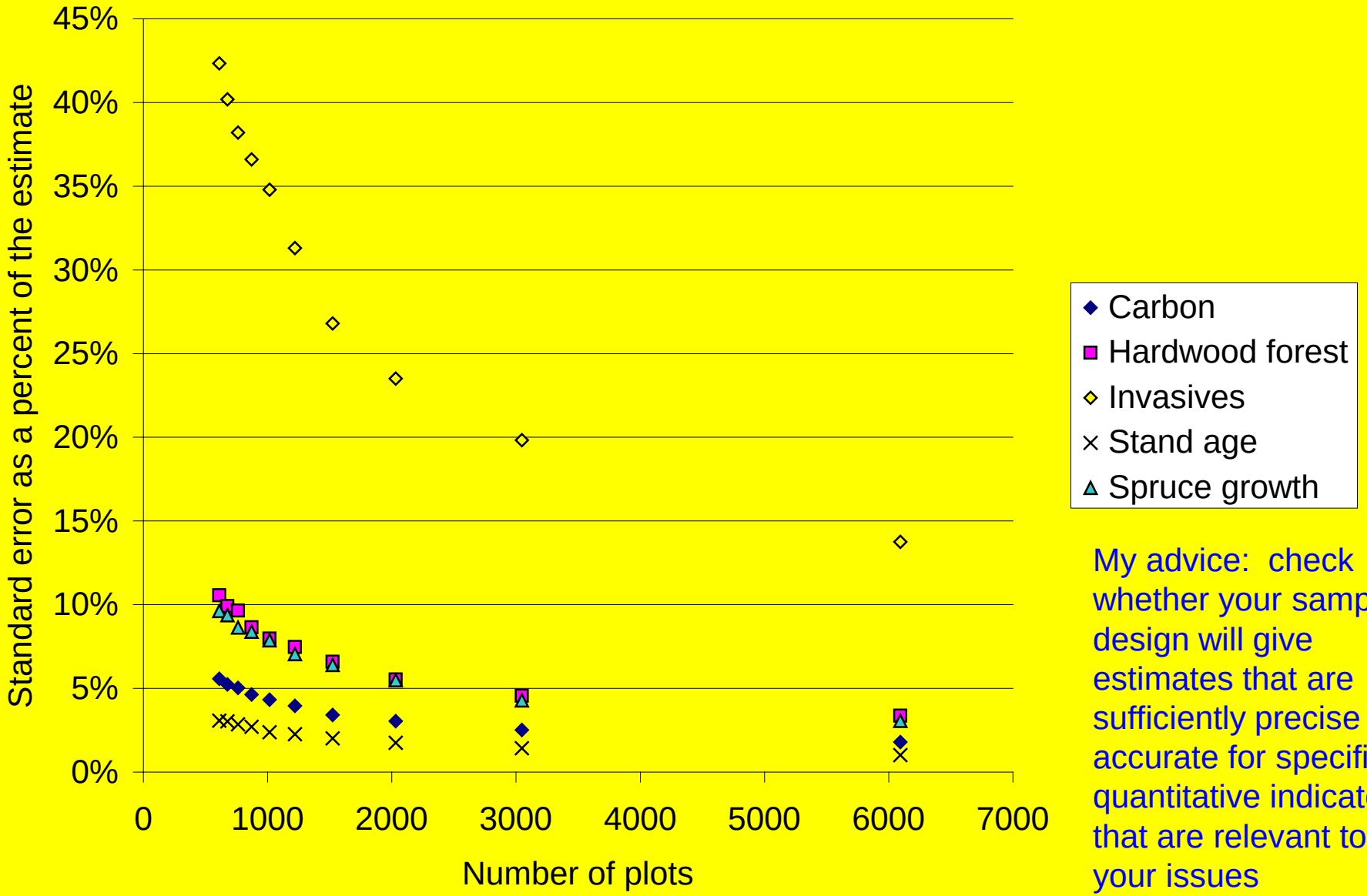
In theory, each panel can be used by itself as an annual sample.

Each hex is about 6000 acres or 2400 hectares.
One plot is randomly located within each hex.
If the plot contains any forest, measurements are taken.



Linear spruce mosaic along the Copper River Delta (8/17/2008)
Plots don't capture spatial relationships – plots need to be combined with remote sensing data if info on things like patch size, connectivity, proximity are needed.
FIA uses a variety of remote sensing info – often combined with USGS's NLCD or other LandSat TM products.

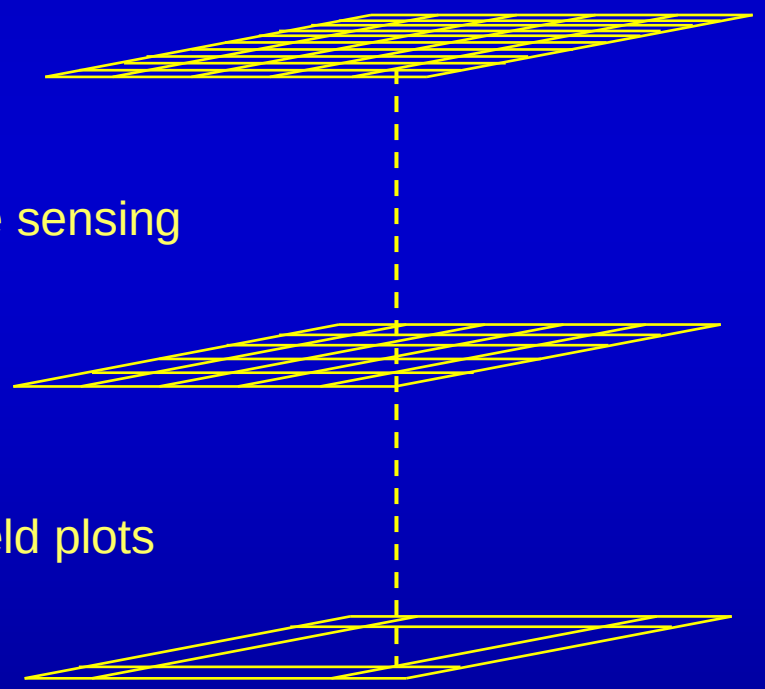
Precision of 5 climate-related indicators as a function of number of field plots for the Tanana inventory unit



My advice: check whether your sampling design will give estimates that are sufficiently precise & accurate for specific quantitative indicators that are relevant to your issues

Methods - interior Alaska inventory design

Because field data is expensive in interior Alaska, we're proposing to supplement it with LIDAR. LIDAR improves precision for biomass, carbon, canopy cover, but doesn't help much with things like invasives, soil composition, or species diversity: for those, we need the field plots.



Low resolution: areal complete imagery. LandSat TM, SPOT

Phase 1: Remote sensing

Moderate resolution: subsampling with LIDAR

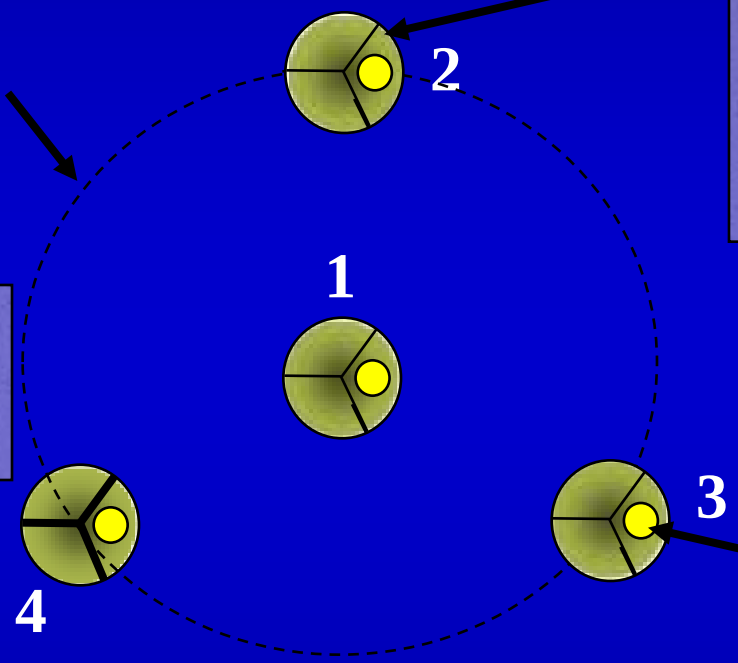
Phase 2 & 3: Field plots

High resolution: Field data with measurements of trees, shrubs, moss, soils, down wood.

Plot Design

Lichen Plot (P3):
(120 ft radius)
Diversity and abundance.

Subplot (24 ft radius):
P2: Tally all trees ≥ 5" dbh
P3: Understory veg cover by lifeform by height



Soil samples (P3)
Cores taken for lab analysis

Transects (P3): Tally coarse & fine woody debris; collect ground cover data.

Vegetation quadrats (P3) – three 1 m² quadrats per subplot)
all species identified

Microplot (P2) (6.8 ft radius) Tally seedlings & saplings
Collect fuels data

A brief history of ‘annual FIA’

1980s – regionalized inventory systems that

- did not include all lands
- did not measure things the same way
- were always outdated
- were a royal pain to try to combine
- had fairly inaccessible data

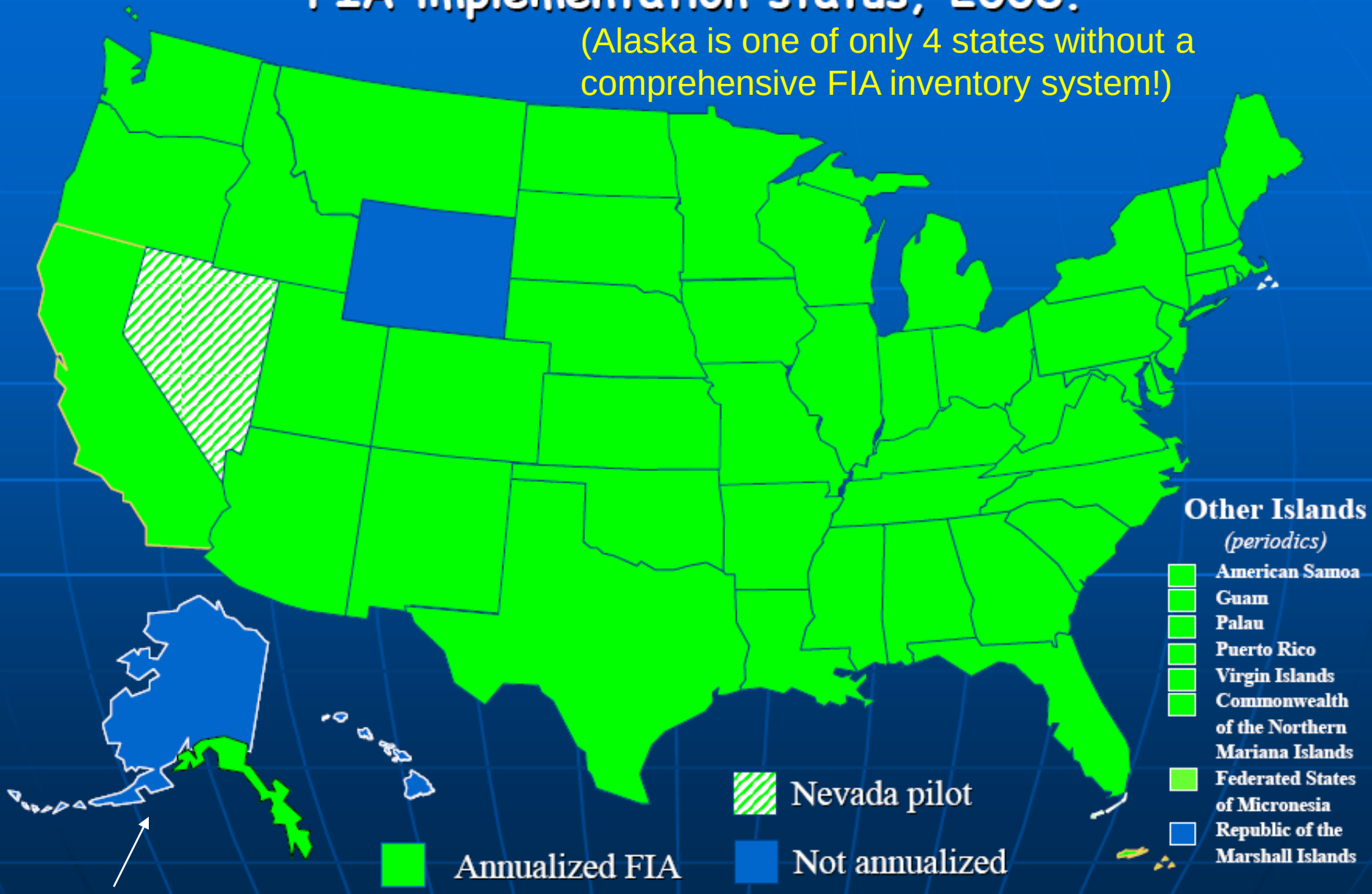
1990s – Two Blue Ribbon Panels review the program

1998 – The Farm Bill completely revamps FIA

1998 – 2008: Annual inventory is implemented, state by state, as the program approaches ‘full funding’

FIA implementation status, 2008.

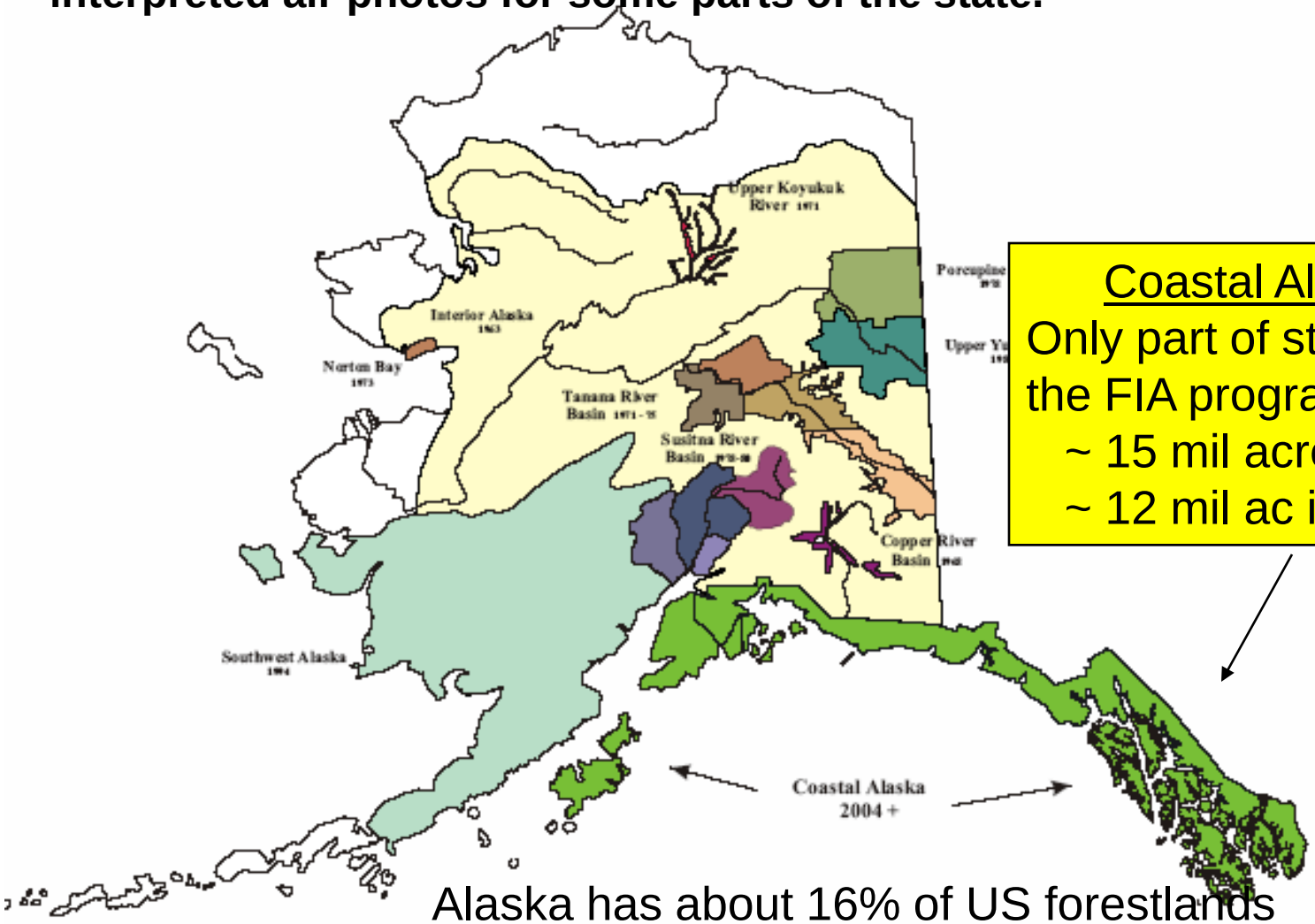
(Alaska is one of only 4 states without a comprehensive FIA inventory system!)



Alaska – that island off the coast of California

Forest inventories of Alaska 1960 to present

Approximate forest land area of Alaska ~ 127 million acres
Alaska is the only state that has never had a complete forest inventory – the official U.S. forest stats for Alaska still uses info from 1960s interpreted air photos for some parts of the state.



Coastal Alaska unit
Only part of state currently in the FIA program
~ 15 mil acres of forest
~ 12 mil ac in inventory

Alaska has about 16% of US forestlands

By most measures, nationally the ‘annual FIA’ program is thriving:

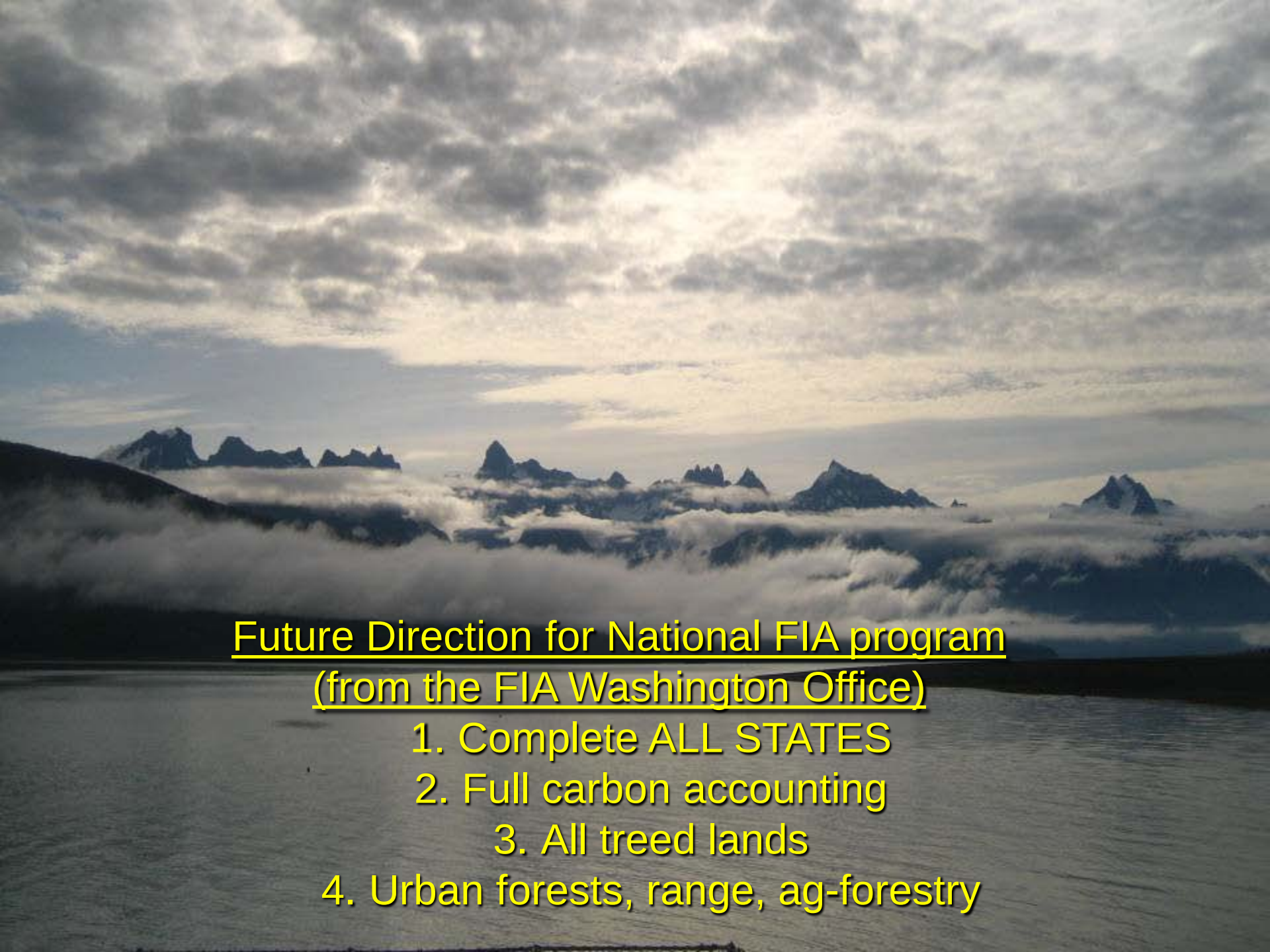
24,000+ data downloads per year

Broad array of external supporters

47,559 plots measured in 2008

Very close to full funding nationally & triple the budget of 1997. (However, interior Alaska is not yet funded.)

172 publications/reports last year by FIA, many more publications that use FIA data



Future Direction for National FIA program
(from the FIA Washington Office)

1. Complete ALL STATES
2. Full carbon accounting
3. All treed lands
4. Urban forests, range, ag-forestry

Lessons learned - annual FIA

(Tara's personal opinions)

1. Some of the babies were thrown out with the bath water (long-term monitoring).
2. Corollary: Don't mess with the inventory design!
3. Standardization of methods was difficult and contentious, but more-or-less worked out.
4. A simple sampling design is flexible and durable.
5. A monitoring system that ignores all boundaries is most excellent.
6. Change needs to be managed.

Lessons learned (continued)

7. Know what the key questions are, figure out how to answer them, keep the measurements focused.
8. Decision by consensus works most of the time.
9. Good leadership is most helpful for those other times.
10. If you ignore QA (data quality), it will sneak up and destroy you.
11. Corollaries: measure your measurement error; use the data as soon as possible; start with the assumption that mistakes will be made; use systematic QA process to reduce error; hire good people, train them & retain them;
12. Empower everyone to question anything.

Lessons learned (continued)

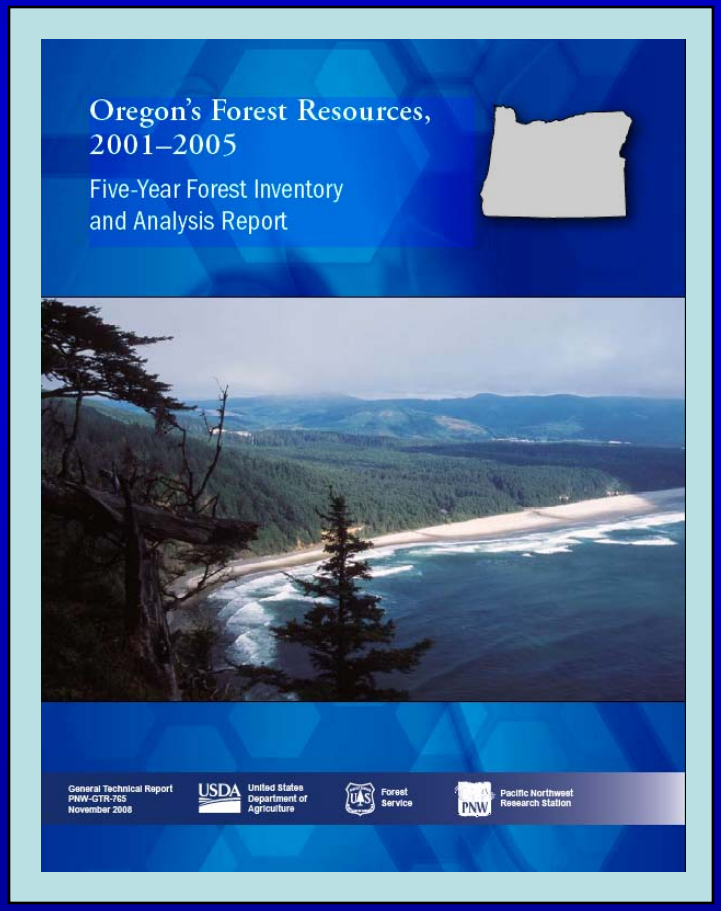
(Tara's personal opinions)

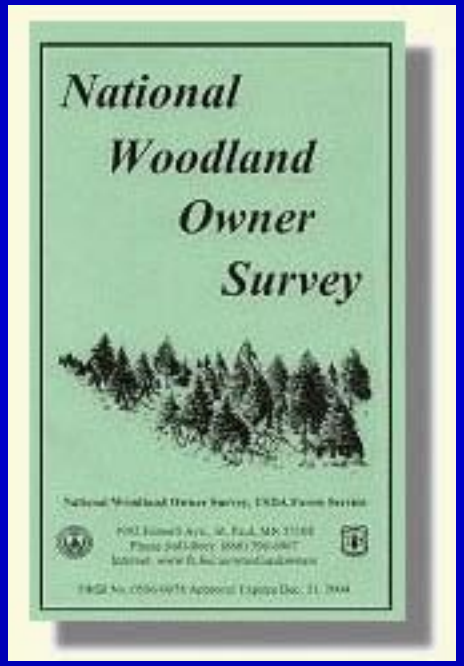
13. External support drives everything.
14. A business model keeps the WO happy.
15. Data delivery was critical.
16. Information management is always the bottleneck.
17. Embedded scientists – painful to be one, but useful for avoiding errors.
18. Sharing ideas, resources, costs, work, & benefits across agencies & programs is very very good.
19. You can't measure all things for all people.
20. No more messing with the inventory design!

The bread-and-butter, the cool, and the slightly scary uses of FIA data

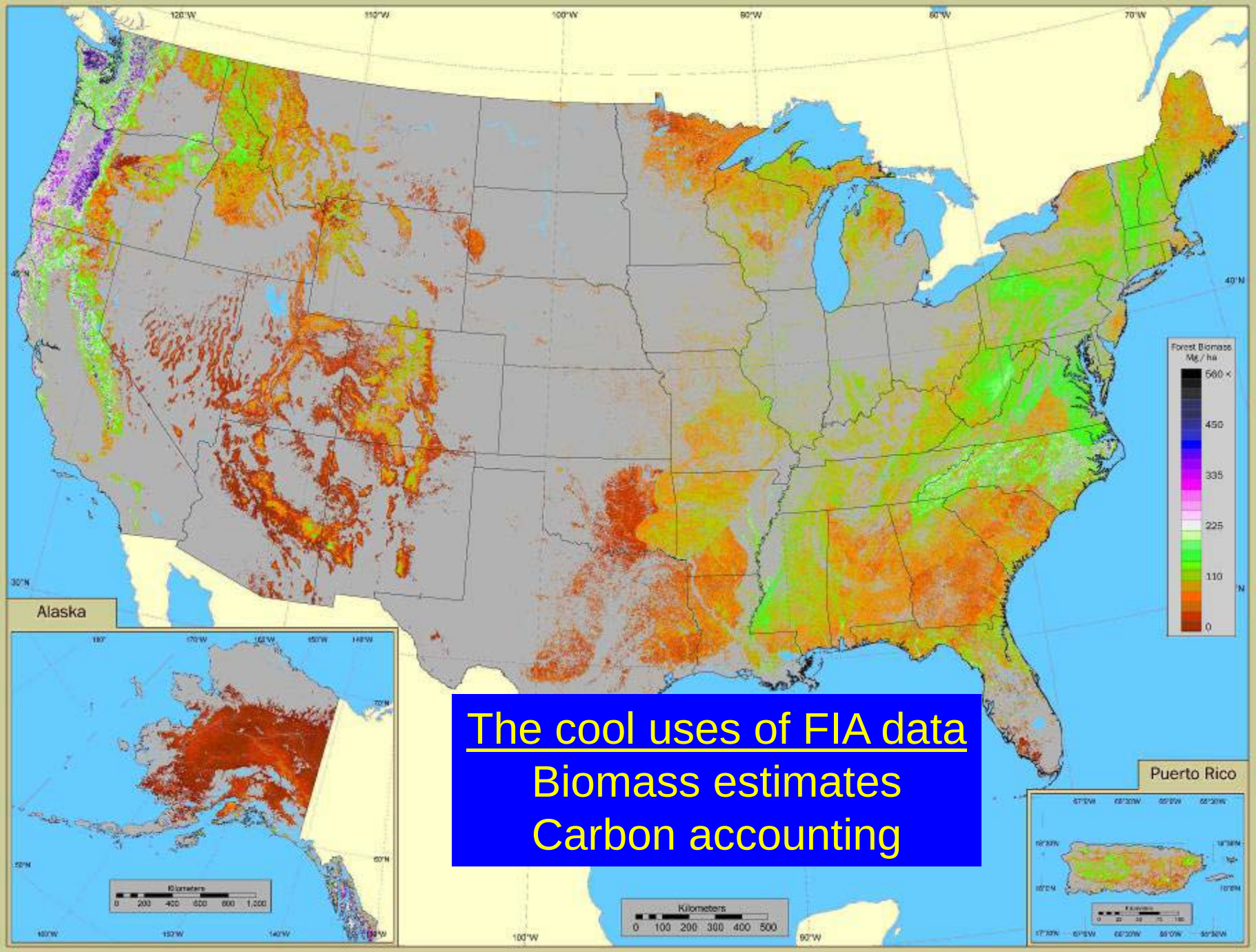
Birch forest on Kenai, Alaska, 7/7/2007

The bread-and-butter
State reports, national reports, owner surveys, mill surveys





Alaska's Timber Harvest and Forest Products Industry, 2005



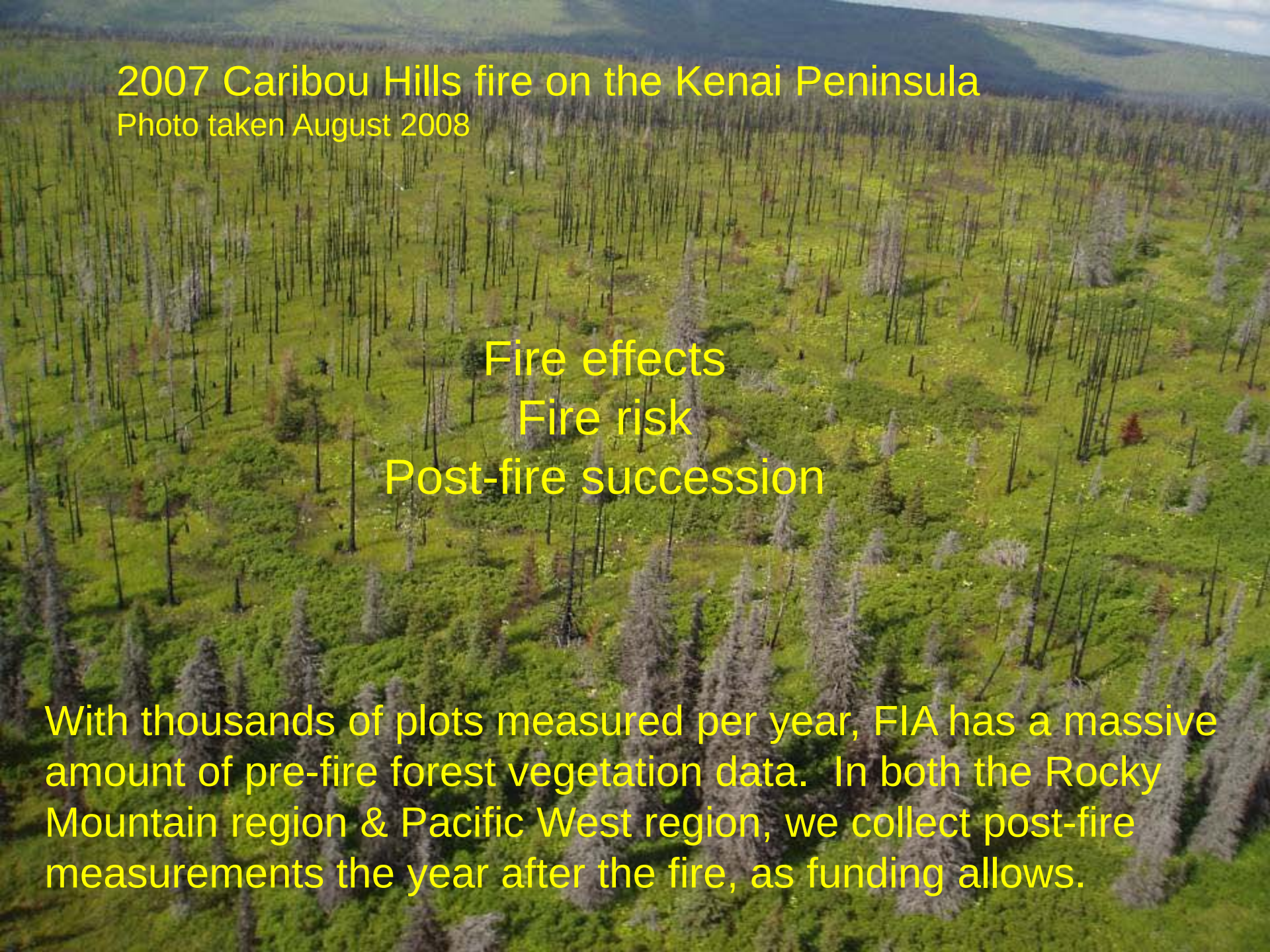
The cool uses of FIA data

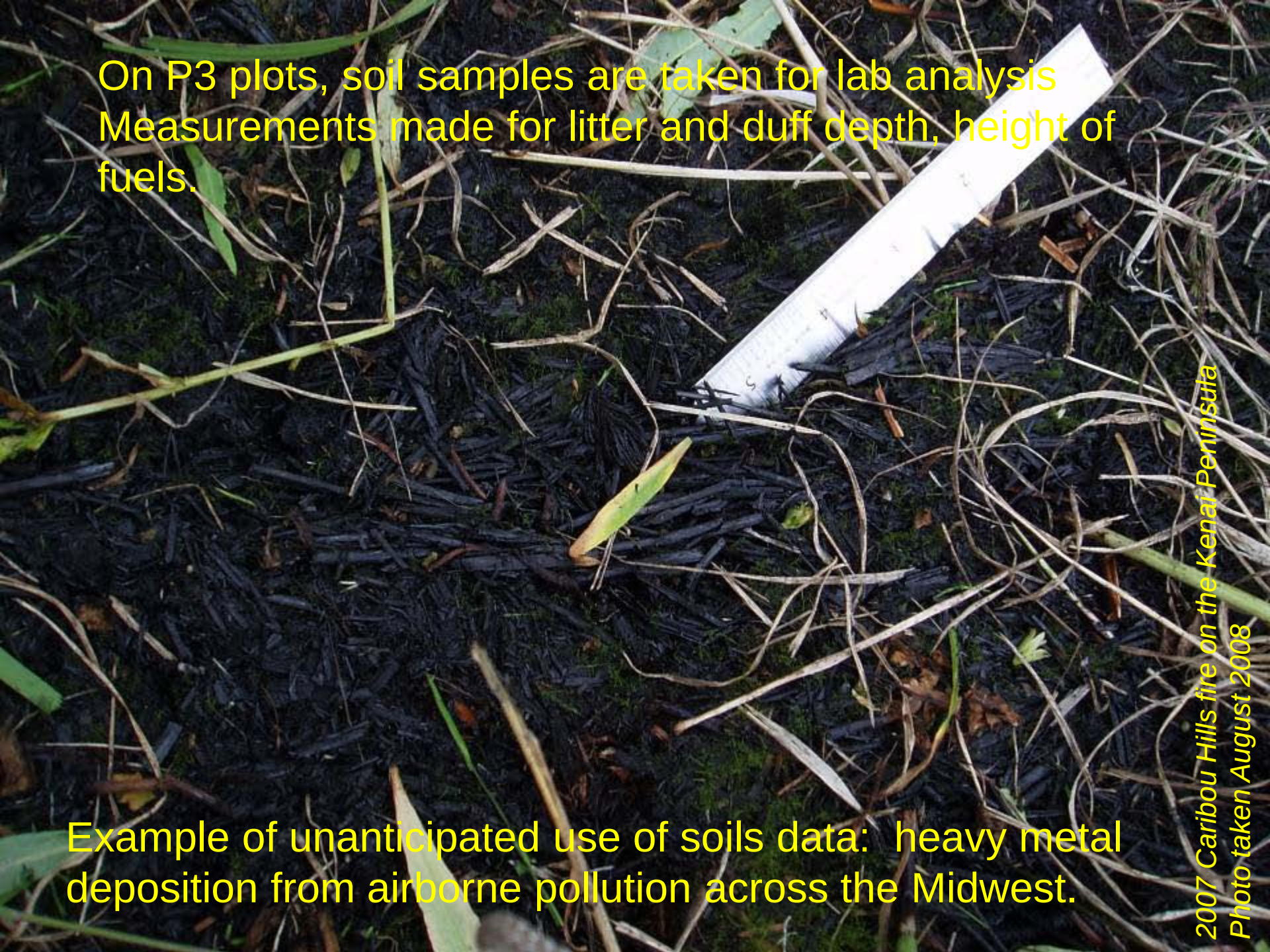
Biomass estimates

Carbon accounting

Lichen diversity, understory plant diversity (P3 plots)

Moss, cloudberry dwarf birch & labrador tea mosaic
J. Bednarczyk, 2004 FIA field crew


2007 Caribou Hills fire on the Kenai Peninsula
Photo taken August 2008
Fire effects
Fire risk
Post-fire succession
With thousands of plots measured per year, FIA has a massive amount of pre-fire forest vegetation data. In both the Rocky Mountain region & Pacific West region, we collect post-fire measurements the year after the fire, as funding allows.

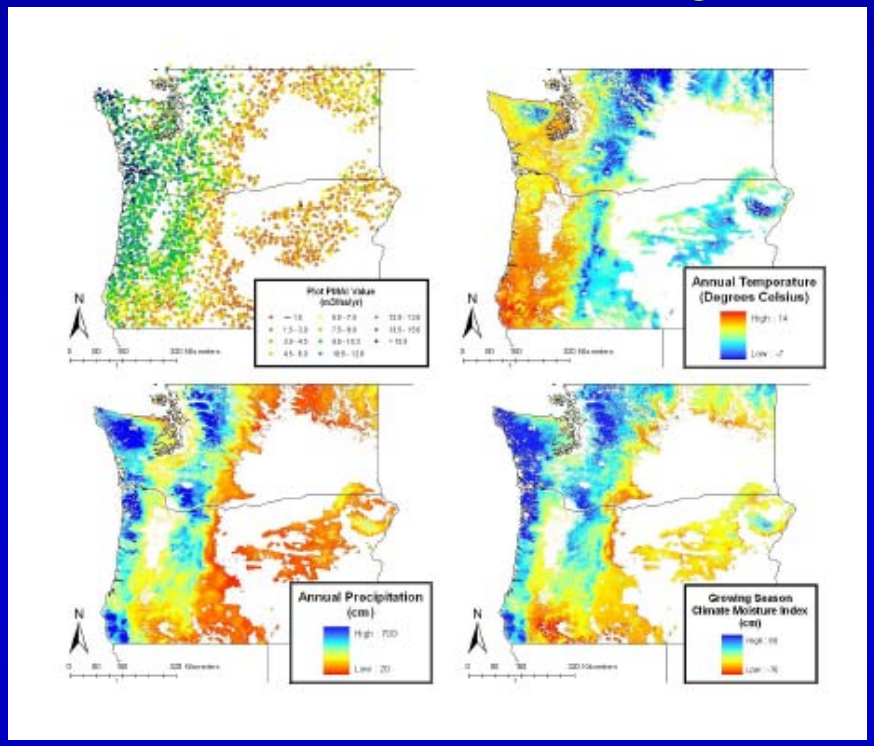

On P3 plots, soil samples are taken for lab analysis
Measurements made for litter and duff depth, height of fuels.
Example of unanticipated use of soils data: heavy metal deposition from airborne pollution across the Midwest.
2007 Caribou Hills fire on the Kenai Peninsula
Photo taken August 2008

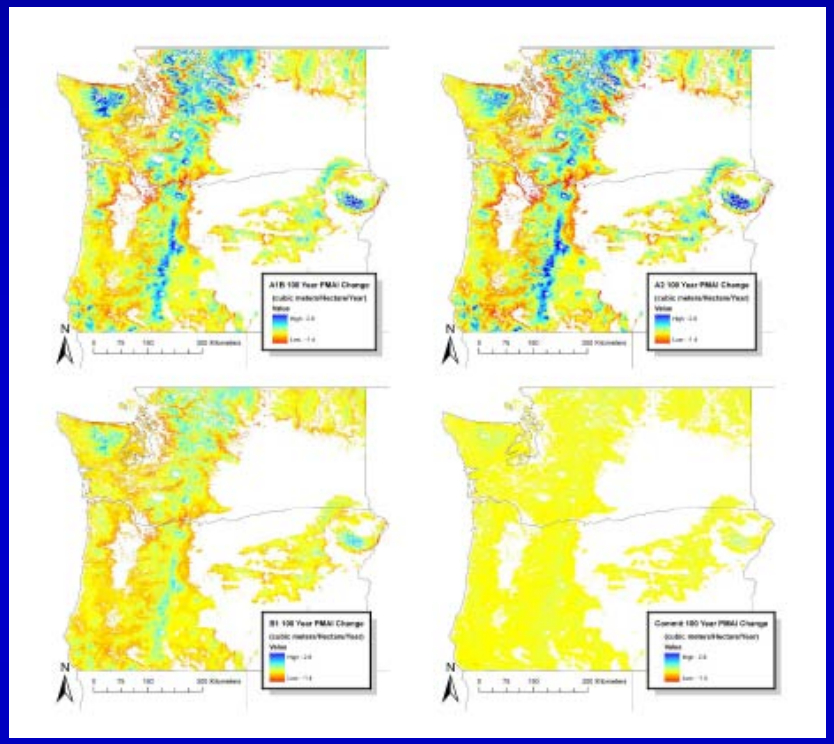
The slightly scary uses of FIA data

Changes in forest attributes in relation to climate

Oregon & Washington forest productivity

G. Latta, H. Temesgen, D.Adams, T. Barrett, in review

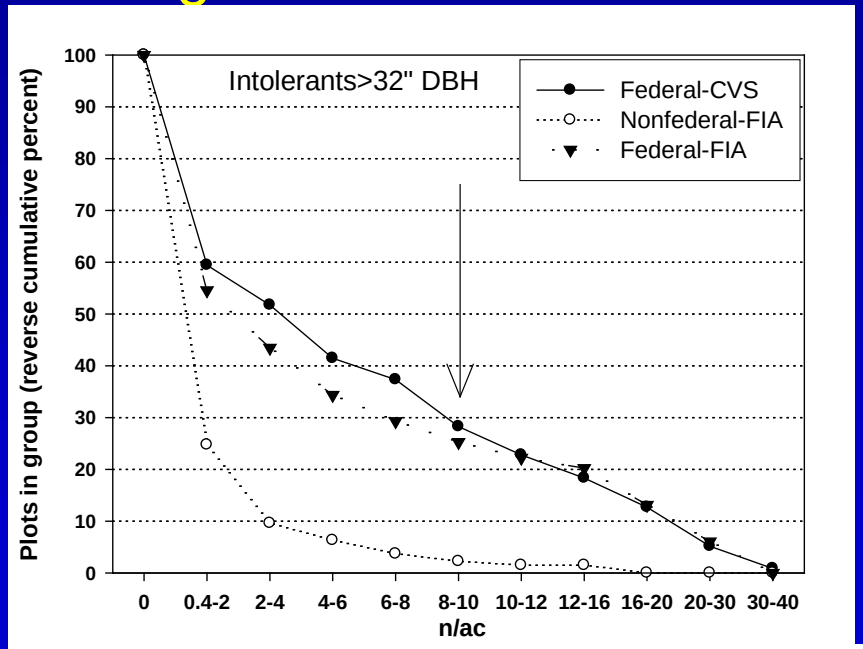


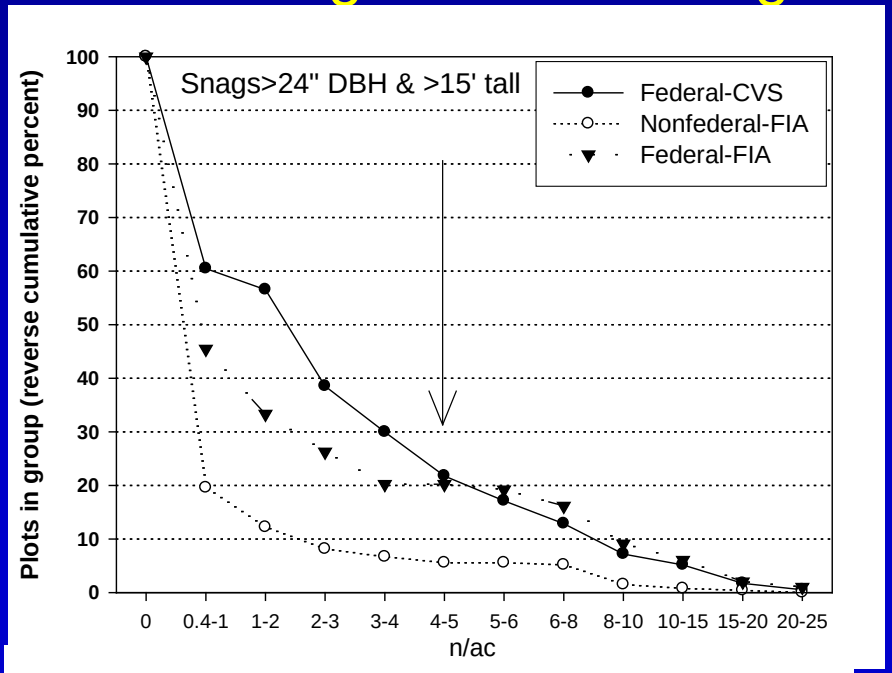


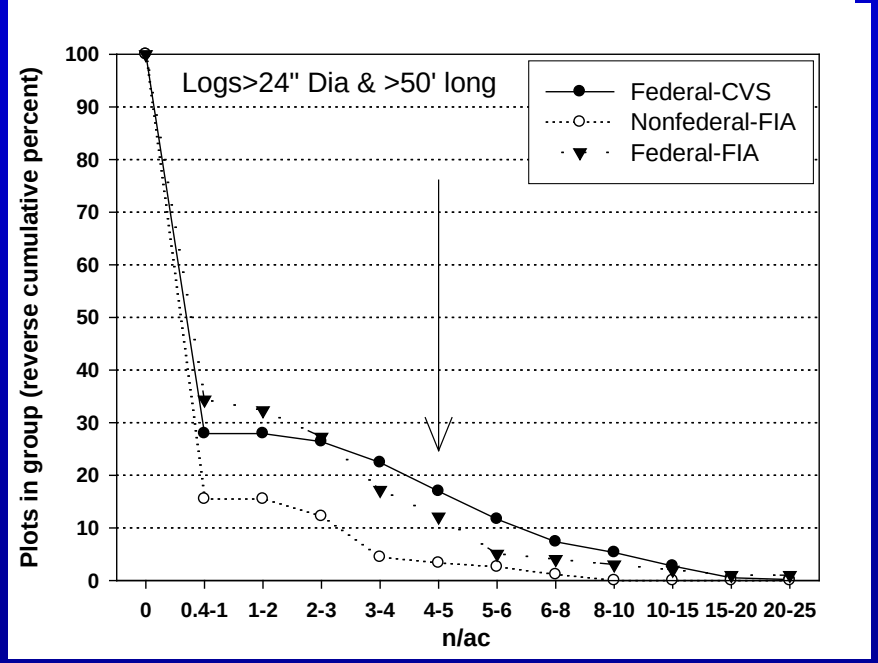
Inputs: observed potential forest productivity (FIA), climate moisture index, temperature, IPCC scenarios of climate change, GCMs

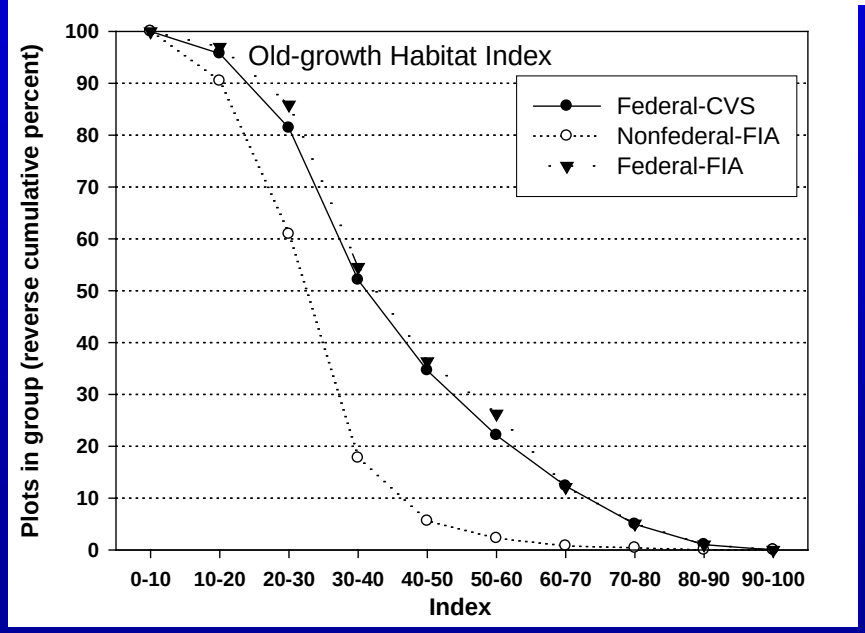
Outputs: predictions of changes in future forest productivity for a variety of IPCC scenarios of climate change

Old-growth forest characteristics in the Oregon Coast Range







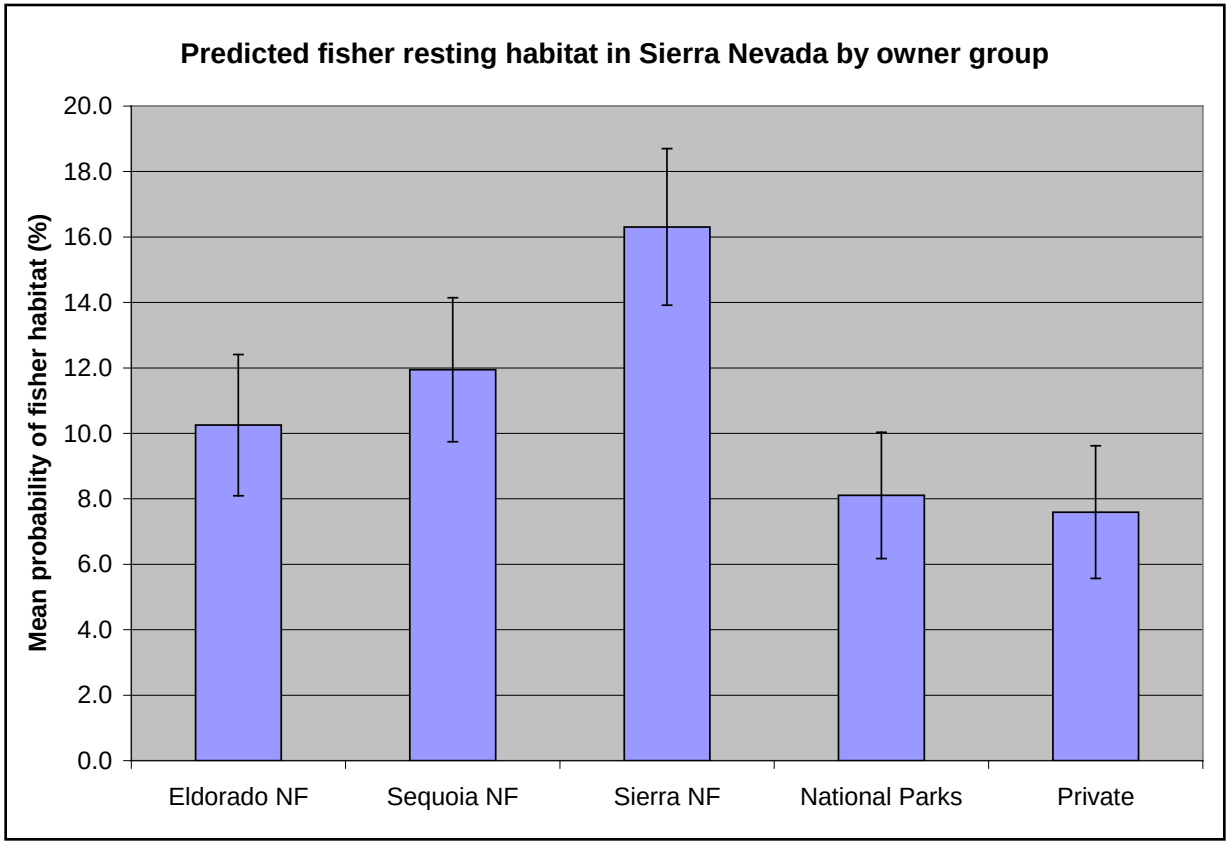


Rare species habitat model: resting sites for American fisher

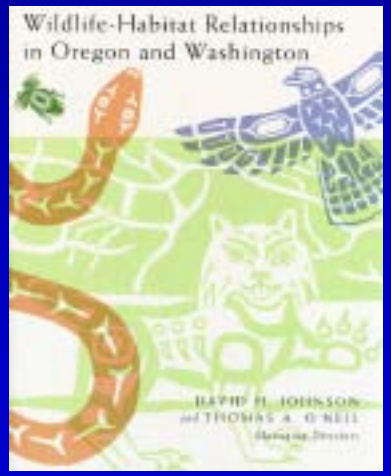
Cooperator: Bill Zielinski, PSW Station

Approach:

- Identify resting sites by following movement of radio-collared animals
- Install full FIA plots centered on resting site
- Compare resting site plots with FIA plots in the region to build predictive models from important attributes (snags, large trees, cover in this case)
- Apply models to FIA plot data to predict habitat availability



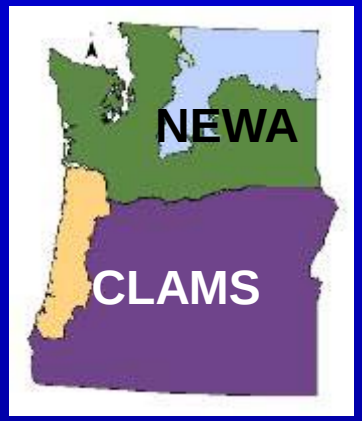
Estimating wildlife habitat with FIA



Andy Gray and others

Used Johnson & O'Neil: *Wildlife-Habitat Relationships in Oregon and Washington* and related to FIA:

- Plant association type
- Stand structure (size class + layers)
- Habitat elements: snags, logs, proximity to water



- Study used two different regions where GNN imputation available
- Used field data and range and stream maps to classify breeding habitat for 238 species
- Imputed habitat availability to create maps

© H. Wallays

© Michael Quinton

© Jason Joyner

© John Kipping

Reasonable breeding habitat acres for most species

Bobcat (*Lynx rufus*)

– EWA: 71% of forest land

– WOR: 84% of forest land

Douglas squirrel (*Tamiasciurus douglasii*)

– EWA: 6% of forest land (only in Cascades)

– WOR: 52% of forest land

Western bluebird (*Sialia mexicana*)

Requires snags ≥ 10 in DBH

- EWA: snag criteria reduced area from 32 to 17% of forest

- WOR: snag criteria reduced area from 23 to 14% of forest

Problems estimating breeding habitat acres

Rough-skinned newt (*Taricha granulosa*)

Requires riparian habitats (poorly defined in Johnson and O'Neill) and "water nearby" (not available for most periodic data)

- EWA: water reduced area from 1.4 to 0.3% of forest
- WOR: water reduced area from 0.7 to 0.3% of forest

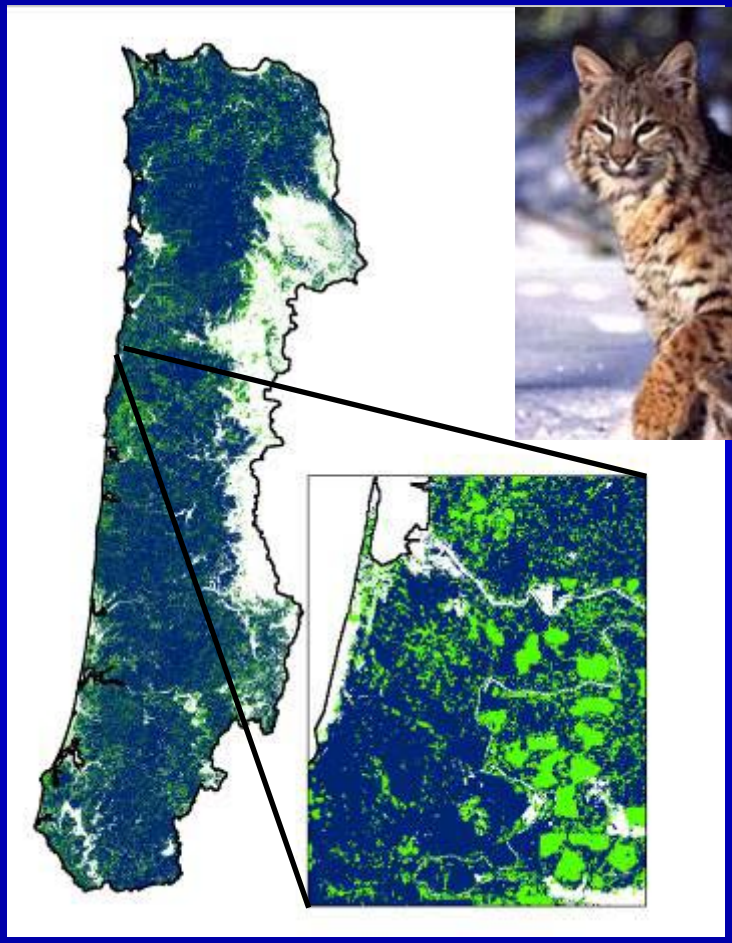
American Pika (*Ochotona princeps*)

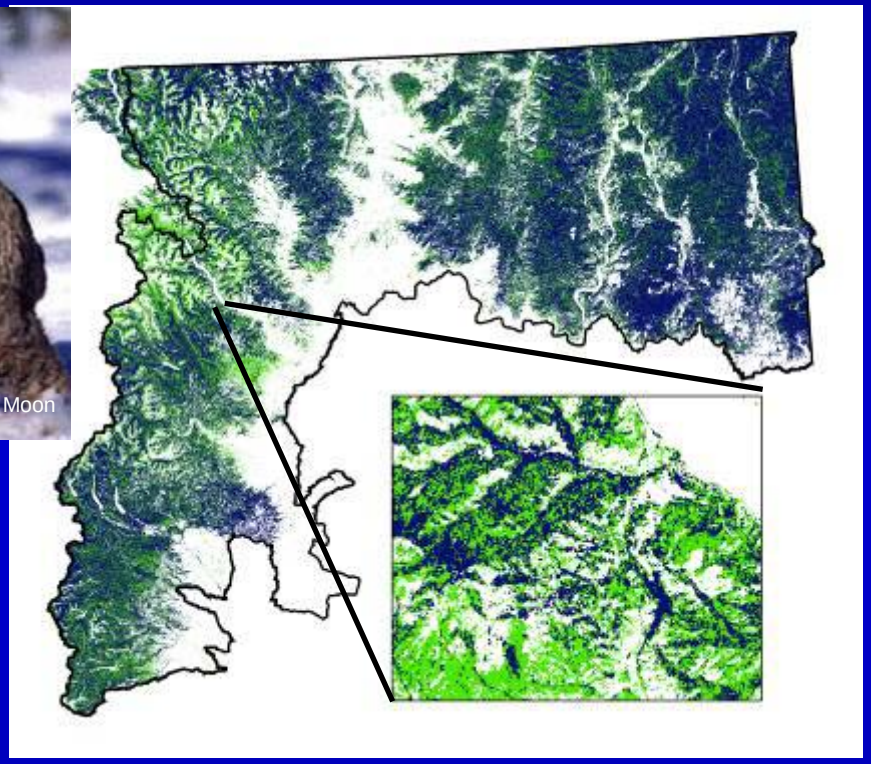
Requires talus, scree, or boulders (no data available), high meadows (but no elevation or other criteria in Johnson and O'Neill)

- EWA: 5% of forest area
- WOR: 0% (not found in Coast Range)

Mapping species habitat with GNN imputation

Bobcat (*Lynx rufus*)





To do: Incorporate minimum patch size requirements and water proximity, compare spatial and non-spatial estimates

Questions?