Forest Plan Monitoring

The Broader Scale Monitoring Strategy

Genesis of the BSMS R3/R2 Pilot

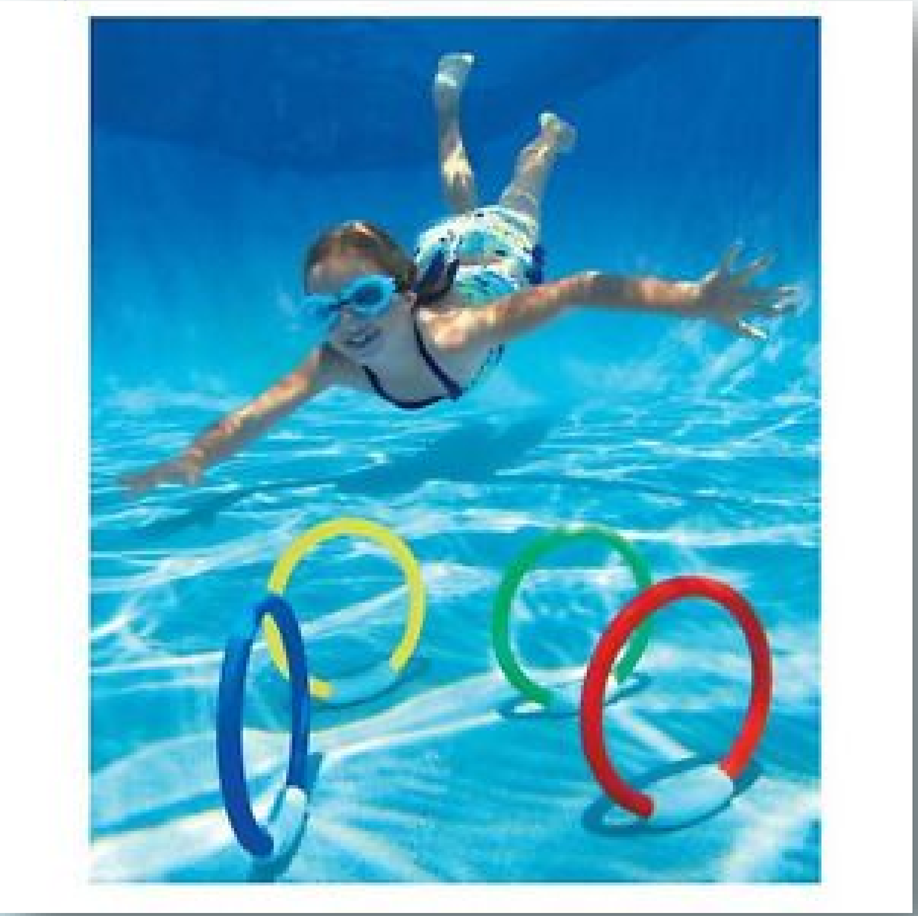
IMA Strategy

Measure Once Use Many Times

Create a pool of nationally consistent, scientifically sound, statistically robust, data that can be used to answer many questions.

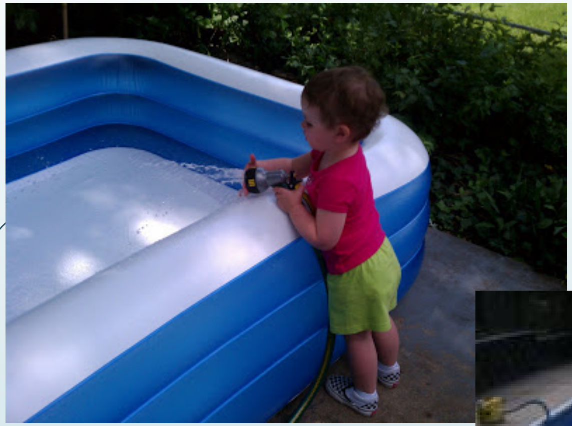
DataPool

IMA Vision



Land managers can dive into the IMA data pool to find the natural resource
information they need
to collaboratively manage forests and rangelands.

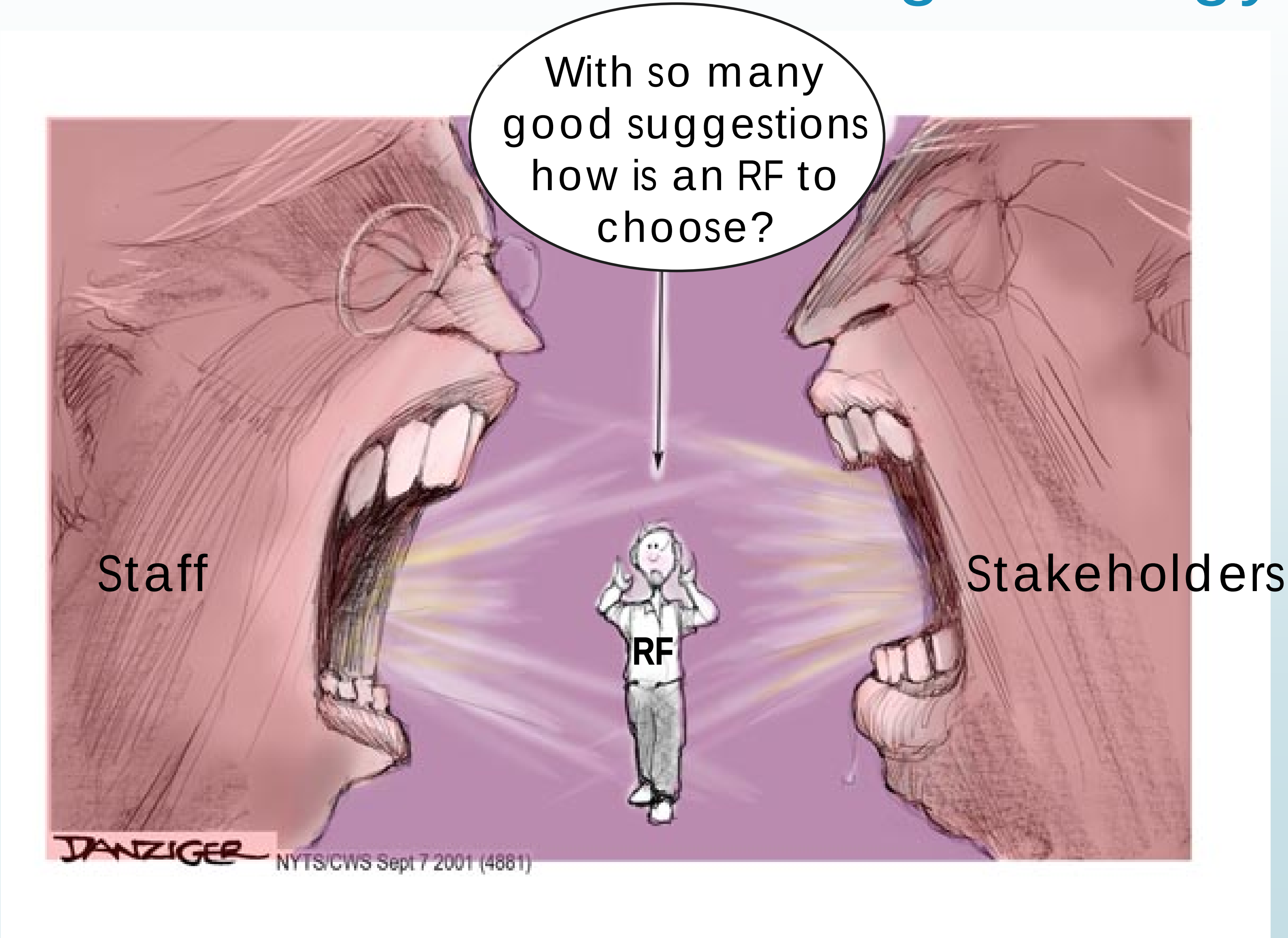
What kind of data pool and how do we fill it?



Broader-Scale Monitoring Strategy
Why a Pilot?

What do we get from a Broader-Scale Monitoring Strategy?

The Challenge of Establishing a Broader-Scale Monitoring Strategy?



Three Steps for Monitoring Aspen Restoration

After conifer removal does aspen sprout?

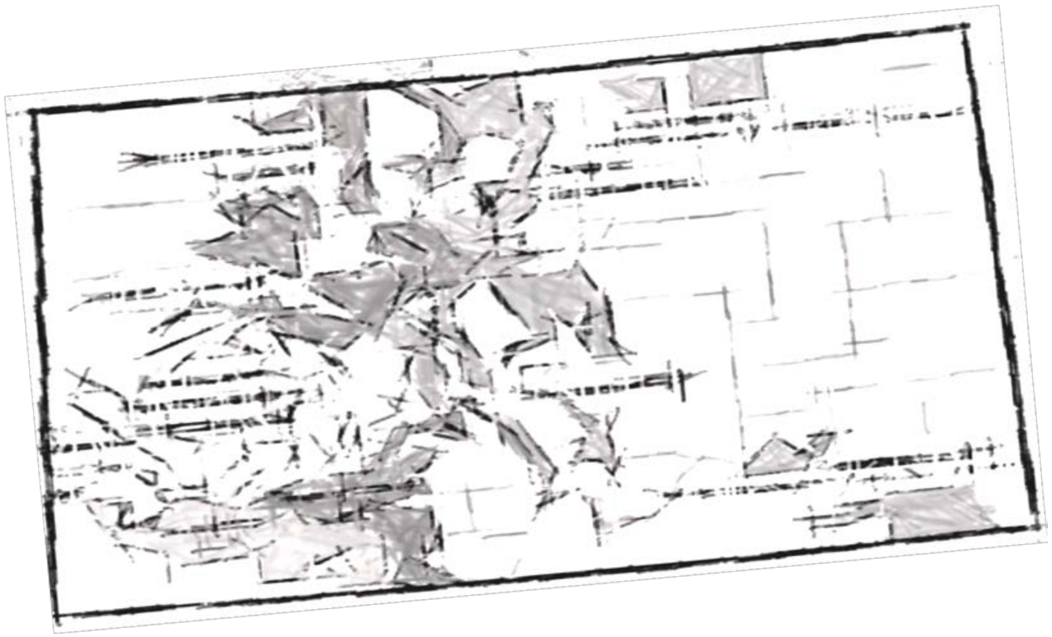
Does aspen survive?

How well is aspen distributed across the landscape?

Questions ???

Broader Scale Monitoring and Forest Planning

Denver - April 2016

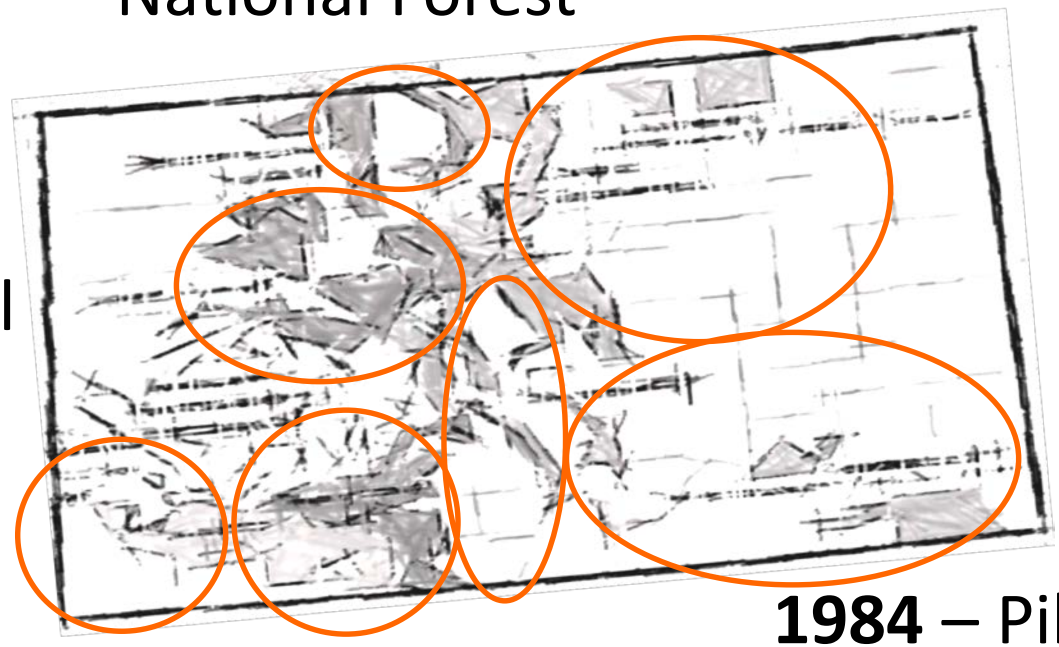


Trey Schillie - Regional Inventory, Monitoring, and Climate Change Coordinator

1997 - Arapahoe and Roosevelt National Forests and Pawnee

1998 – Routt National Forest

2002 – White River National Forest



2013 – San Juan National Forest

1991 – GMUG National Forests

1996 – Rio Grande National Forest

1984 – Pike and San Isabel and Cimarron and Comanche

2012 Planning Rule*:* Monitoring framework designed to:

- Test assumptions, track changes, and measure progress toward achieving desired conditions

- Monitoring at two scales
  - Forest Plan Monitoring (Forest Supervisor)
  - Broader Scale Monitoring (Regional Forester)

2012 Planning Rule*:* Forest Plan-Level Monitoring

- Monitoring Transition: National Forests and Grasslands not in revision, required to update existing monitoring chapters by May 9, 2016

- 2012 Planning Rule provides 8 categories. Must have at least one monitoring question and indicator for each category.

Broader Scale Monitoring

Denver - April 2016

1. Status of select watershed conditions
2. Status of select ecological conditions including key characteristics
3. Status of focal species
4. Status of ecological conditions for TEPC and species of conservation concern (SCC)
5. Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives
6. Measureable changes of climate change and other stressors
7. Progress toward meeting social, economic and other desired conditions
8. Effects of management system… impair productivity of the land (soils)

2012 Planning Rule*:* Forest Plan-Level Monitoring

- Transition process to remove obsolete, redundant, or monitoring items too expensive or uninformative
- Added regionally-consistent monitoring items
  - Watershed Condition Framework
  - National BMPs
  - Annual insect and disease aerial surveys
  - SNOTEL

2012 Planning Rule*:* Forest Plan-Level Monitoring

Are these the right questions?

- *Are standards and guidelines prescribed being incorporated in NEPA documents and implemented on the ground?*

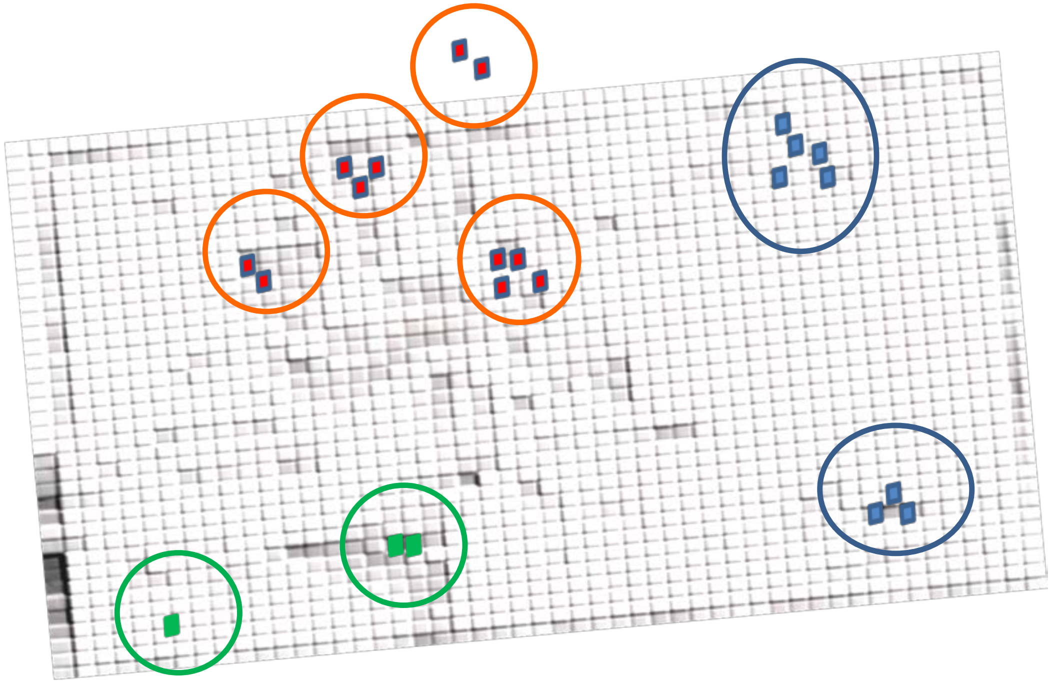
  REMOVE

- *How are projects and programs affecting visual quality?*

  What are the status and trends of visibility in the plan area?

Broader-Scale Monitoring and the 2012 Rule

- Regional Forester strategy questions and indicators best addressed at larger scale than a single plan area



Forest Plan Monitoring

Considerations:

- Monitoring that can be implemented through flat budget scenario (*What we don't need to monitor might be as important as what we do need to monitor*)
- Opportunities for enhanced consistency
- Existing programs and monitoring efforts

Broader-scale Monitoring

GOALS AND SCALES

Forest Plan Monitoring Aspects

Better inform forest-level decisions

- Test relevant assumptions
- Measure management effectiveness in order to assess progress toward achieving or maintaining desired conditions
- Track relevant changes, including, but not limited to:
  - Risks, stressors and conditions beyond unit boundaries

Ecological Scale

- Ecological phenomena have spatial & temporal variability
  - Vegetation patterns
  - Biotic responses
  - Disturbance regimes
  - Etc.

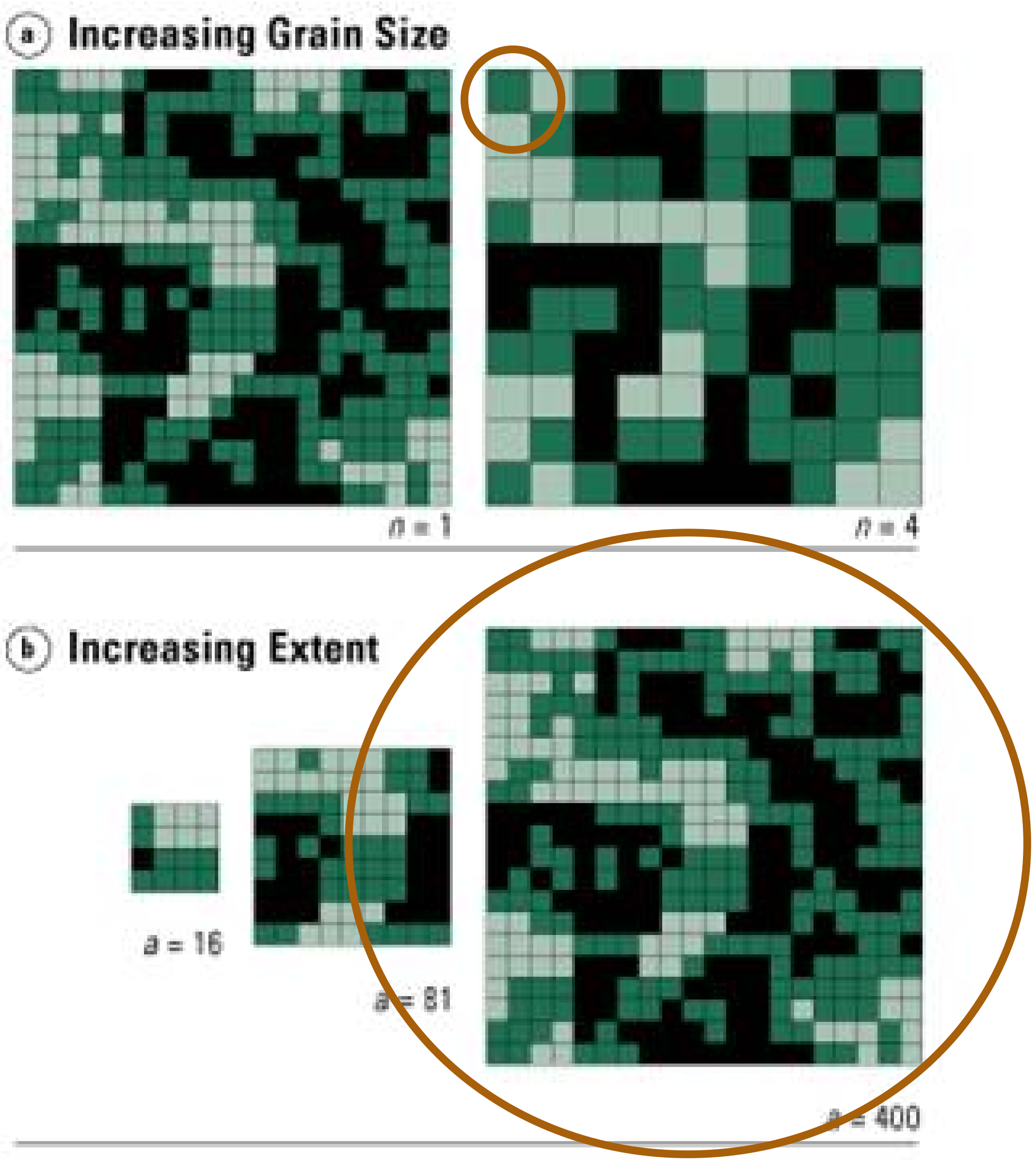
Scale : the spatial or temporal dimension of an object or process, characterized by both ***grain*** and ***extent*** **(**Turner et al. 1989)

Components of Scale

- Characterized by:
  - Grain
  - Extent

- ***Grain*** – finest ***spatial resolution***
  (cell size or pixel size)

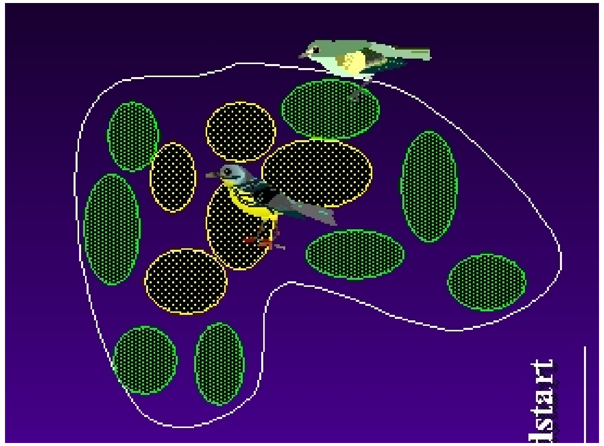
- ***Extent*** – the ***size*** of the overall study landscape (multi-forest, watershed, HUC, ecoregion)



Ecological Scaling: Components of Scale

- Grain and extent often dictated by scale of available spatial data (e.g. spatial layers & imagery), logistics, or technical capabilities

Ecological Scaling: Scale & Pattern

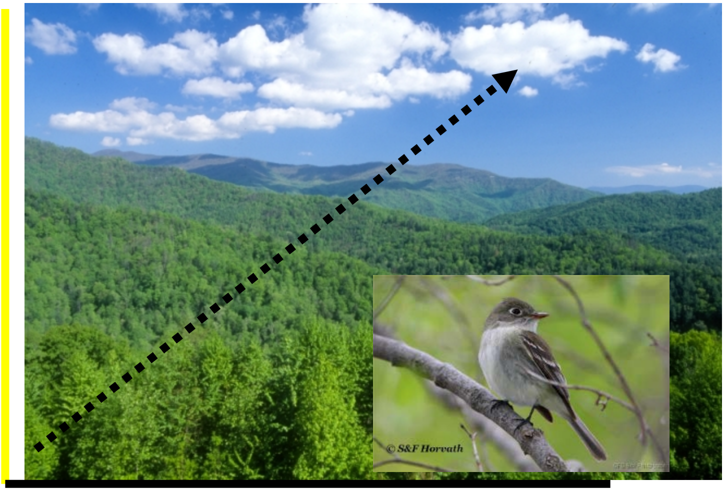


- Different patterns emerge, depending on the scale of investigation

Local Scale
(4 ha plots)

Western Bluebird

Regional Scale
(thousands of ha)



Least Flycatcher

Ecological Inference: Patterns and Scale Matter

How Do:

Habitat types
Patch sizes
Patch Arrangement
Connectivity

Affect:

Species Distributions
Community Parameters
Ecosystem Processes

Ecological indicators at different scales

Ecosystem components	Population/Species	Ecosystem/Community	Landscape/Region
Composition	Presence, Abundance, Frequency, importance, cover, biomass, density	Identity, abundance, frequency, richness, evenness and diversity of species and guilds; presence and proportions of focal species; dominance diversity curves; life form distributions; similarity coeffecients	Identity, distribution, richness of patch types
Structure	Dispersion, range, population structure, morphological variability	Substrate and soil condition, slope, aspect, living and dead biomass, canopy openness, gap characteristics, abundance and distribution of physical features, water and resources, presence and distribution, snow cover	Spatial heterogeneity; patch size, shape and distribution; fragmentation; connectivity
Function	Demography, population changes, physiology, growth rates, life history, phenology, acclimation	Biomass, productivity, decomposition, herbivory, parasitism, predation, colonization, extrapation, nutrient cycling, succession, small scale disturbances	Patch Persistence; rates of nutrient cycling and energy flow, erosion, geomorphic and hydrologic process, disturbance

	Remote-Assessment Indicators	Rapid-Assessment Indicators	Intensive-Assessment Indicators
Purpose	Indicate status of key ecological attributes at larger spatial scales and/or at coarser spatial resolution	Indicate status of key ecological attributes at intermediate to fine spatial scales or spatial resolution; multiple measurement locations can provide wide spatial coverage	Indicate status and trend of key ecological attributes at fine spatial scales or spatial resolution; multiple measurement locations can provide wide spatial coverage
Data source	GIS and remote-sensing metrics for landscape or waterscape conditions within polygon(s) with limited ground-truthing GIS and remote-sensing metrics for landscape or waterscape conditions across areas with limited ground-truthing	Qualitative or simple quantitative field based metrics including visual, auditory and rapid assessments Bio-assessment methods, and data from portable field-monitoring Instruments Fixed field instruments with data logging at long term monitoring stations	Simple to complex field-based metrics, often quantitative, collected within a statistically appropriate sampling design Laboratory analyses of field samples collected within a statistically appropriate sampling design
Examples	Landscape Metrics – Patch size, heterogeneity, composition, connectivity from Landsat Forest structure (LIDAR) Aerial surveys for insect and disease	Weather stations (snowtel) Stream flow monitoring Vegetation structure (qualitative) e.g PFC Photo-point	Vertebrate species monitoring Plant species absolute density FIA Water or Soil chemistry PIBO/MIM monitoring Common Stand Exam, Daubenmeier protocols

Perspectives on broader scale monitoring

What are some different models for broad-scale monitoring?

A) Top -down strategy: Existing broad scale or all lands data (remote or intensive) from USFS research or partners is analyzed or has value added by USFS or partners to answer specific questions

B) Bottom-up strategy: Information collected by Forest staff is aggregated and analyzed/value added at the Regional Level or by partners (requires standardized protocols)

C) USFS field crews collect data from multiple Forests and data analysis is centralized regionally or sub-regionally by the USFS or partners

Perspectives on a BSMS

How can a BSMS complement Forest planning and Forest plan monitoring?

A BSMS can provide *context* for Forest planning and resource management issues across Forests and landscapes

A BSMS can complement Forest plan monitoring by providing information that Forests may not have the time or resources to collect or analyze themselves

PONDEROSA PINE FOREST DESIRED CONDITIONS

General Description

The ponderosa pine forest vegetation community includes two sub-types: Ponderosa pine bunchgrass and ponderosa pine Gambel oak. The ponderosa pine forest vegetation community generally occurs at elevations ranging from approximately 5,000 to 9,000 feet. It is dominated by ponderosa pine and commonly includes other species such as oak, juniper, and pinyon. More infrequently species such as aspen, Douglas-fir, white fir, and blue spruce may also be present, and may occur as individual trees. This forest vegetation community typically occurs with an understory of grasses and forbs although it sometimes includes shrubs.

Landscape Scale Desired Conditions (1,000-10,000 + acres)

The ponderosa pine forest vegetation community is composed of trees from structural stages ranging from young to old. Forest appearance is variable but generally uneven-aged and open; occasional areas of even-aged structure are present. The forest arrangement is in individual trees, small clumps, and groups of trees interspersed within variably-sized openings of grass/forbs/shrubs vegetation associations similar to historic patterns. Openness typically ranges from 10 percent in more productive sites to 70 percent in the less productive sites. Size, shape, number of trees per group, and number of groups per area are variable across the landscape. Seral state proportions, per the R3 Seral State Proportions Supplement, are applied at the landscape scale, where low overall departure from reference proportions is a positive indicator of ecosystem condition. In the Gambel oak sub-type, all sizes and ages of oak trees are present. Denser tree conditions exist in some locations such as north facing slopes and canyon bottoms.

Old growth occurs throughout the landscape, generally in small areas as individual old growth components, or as clumps of old growth. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris) and structural diversity. The location of old growth shifts on the landscape over time as a result

Region 3 Desired Conditions

Desired Condition	Relevance to Owl
Strive for a diversity of patch sizes with minimum contiguous patch size of 1 ha (2.5 ac) with larger patches near activity center; mix of sizes towards periphery (Peery et al 1999; Grubb et al 1997; May and Gutiérrez 2002). Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity.	Nest/roost habitat patches are the most limiting habitat for the owl. Patches should enhance spatial heterogeneity, provide nest/roost options, provide varied microclimates (thermoregulation) options, and create edges for prey species (e.g., *Neotoma*).
Horizontal and vertical habitat heterogeneity within patches, including tree species composition.* Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover (Ganey et al. 2003).*	Provides roosting options, thermal and hiding cover for the owl, and habitat for a variety of prey species.
Tree species diversity, especially with a mixture of hardwoods and shade-tolerant species (Willey 1998).* For example, Gambel oak provides important habitat for woodrats and brush mice (Block et al. 2005, Ward 2001)	Provides habitat and food sources for a diversity of prey, roosting options, and perches and hiding cover for young owls during early flight development. Large tree-form Gambel oaks are an important nesting substrate for owls (Ganey et al 1992; SWCA 1992; May and

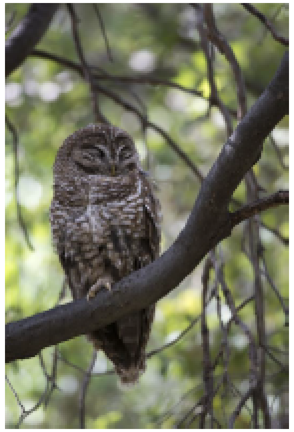
MSO Recovery Plan

Site Occupancy by Mexican Spotted Owls (*Strix occidentalis lucida*) in the US Forest Service Southwestern Region, 2014

30 March 2015

Rocky Mountain Bird Observa
14500 Lark Bunting
Brighton, CO 8
303.659.
www.rmb
Technical Report #SC-MSO-USF

Site Occupancy by Mexican Spotted Owls (*Strix occidentalis lucida*) in the US Forest Service Southwestern Region, 2015



16 November 2015

Bird Conservancy of the Rockies
Connecting People, Birds and Land

Bird Conservancy of the Rockies
14500 Lark Bunting Lane
Brighton, CO 80603
303.659.4348
www.birdconservancy.org
Technical Report SC-MSO-USFS-02

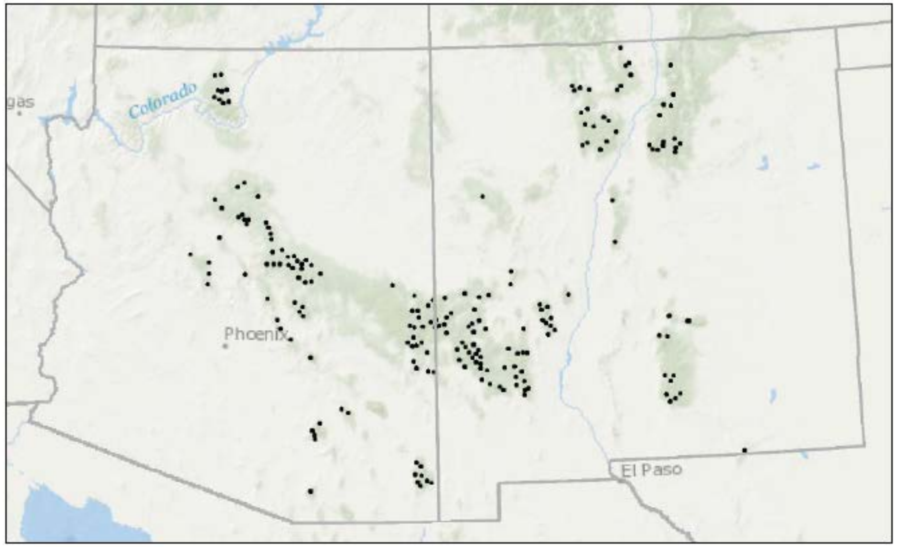
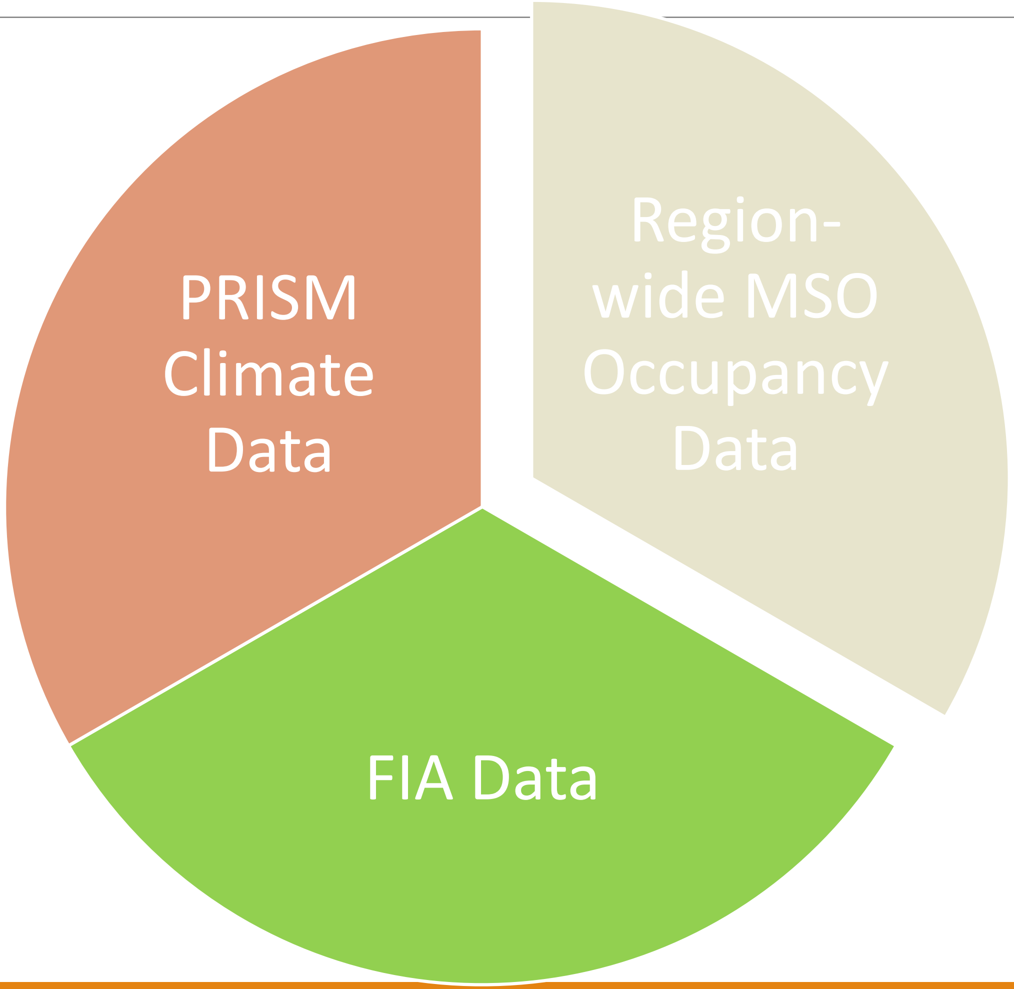


Figure 1. The distribution of sampling units ($n = 201$) surveyed for Mexican Spotted Owl occupancy in 2015 in the US Forest Southwestern Region.

Broader-Scale Monitoring Strategy



What can this BSMS tell us?

Are we achieving desired conditions for ponderosa pine at the landscape level or broader scale?

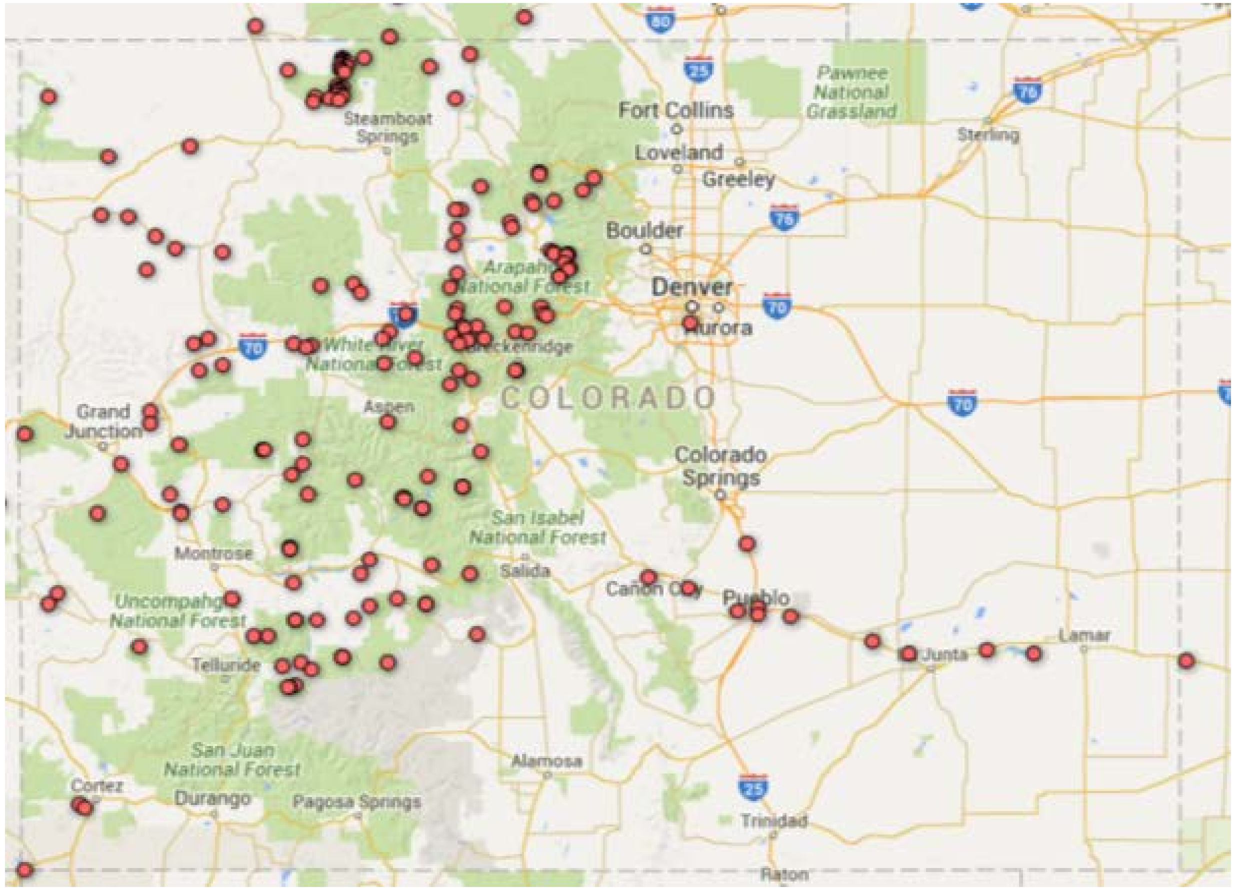
Are our assumptions about suitable MSO habitat holding at the landscape level or broader scale?

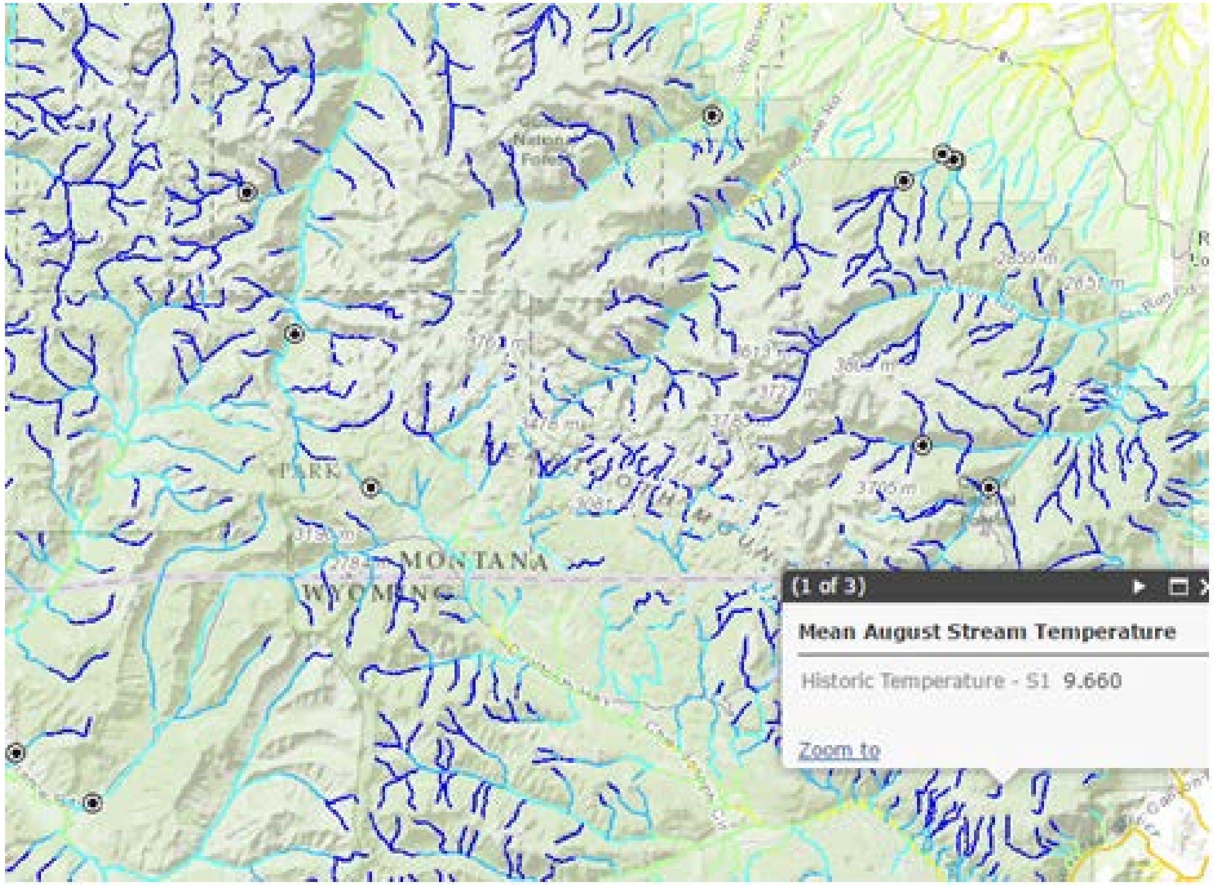
Are MSO occupying the available suitable habitat at the landscape level or broader scale?

How are ponderosa pine forests that have met desired conditions faring in the face of climate change or other stressors? How does that vary at the landscape level or broader scale?

Is MSO occupancy responding to climate change and other stressorsat the landscape level or broader scale?

Existing BSMS: NORWEST stream temperature monitoring





BSMS relevance for specific resource areas

Range, grasslands and invasives (req. 2, req. 6)

- Monitoring is centered at the allotment level, difficult to evaluate long term trends and conditions quantitatively across units and forests
- Need for new Rangeland manual

Watershed/Riparian aquatics (req. 1, 2 and 8)

- Need for cost effective, reliable, and consistent inventory, and monitoring strategies for riparian/wetlands

Resource specific issues

Forest/veg (req. 2 and 7)

- Rapid changes in many cover types (insect/disease)
- CSE’s not meant for inference above stand level; inventory rather than monitoring tool

Wildlife (req. 3 and 4)

- Need for effective and often cross-boundary assessment and monitoring of trends and conditions related to both habitat (req. 4) and species, particularly focal species (req. 2)

Socioeconomic and rec (req. 7)

- Need to understand broader changes and trends in social and economic conditions, (development in WUI, changing demographics, social needs and values)

Long-term Monitoring in the National Park Service

Joe DeVivo
Deputy Chief for Science
NPS Inventory & Monitoring Division
28 April 2016

2016 National Park Service CENTENNIAL

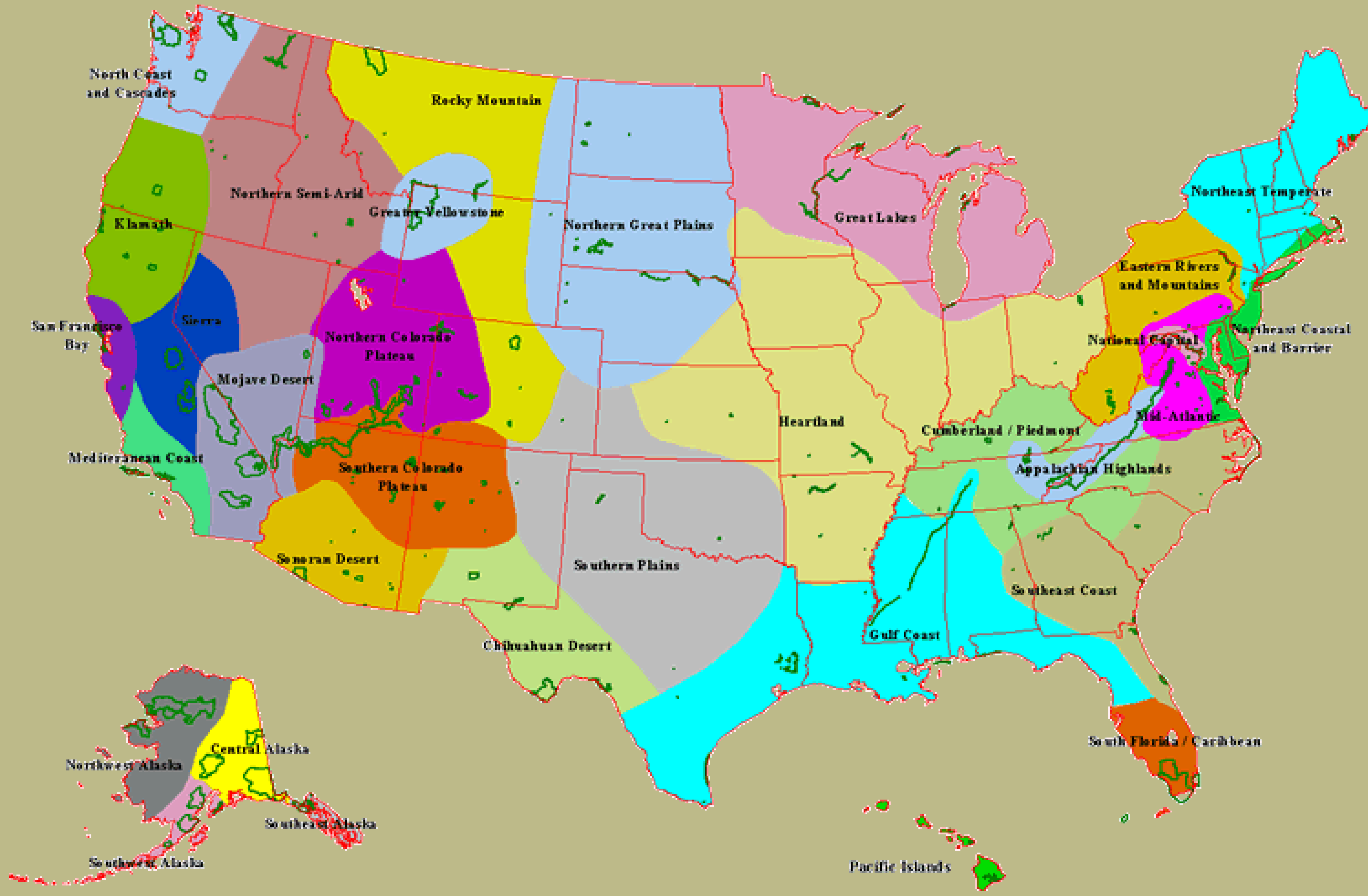
Today's talk

- (Brief) overview of the program
- Big decisions to make
- Expectations & how to navigate them
- Lessons Learned
- Top 10 recommendations when setting up a new program

Five Goals of NPS I&M Program

- **Inventory** the natural resources under National Park Service stewardship to determine their nature and status.
- **Monitor** park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments.
- Establish natural resource inventory and monitoring as a **standard practice** throughout the National Park system that transcends traditional program, activity, and funding boundaries.
- **Integrate** natural resource inventory and monitoring information into National Park Service planning, management, and decision making.
- **Share** National Park Service accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives.

32 Inventory & Monitoring Networks



Monitoring by the Numbers

- 334 Protocols Planned
- 224 Implemented
- > 50% taxonomic based
- ~ 15% taxon-issue based
- The rest
  - Water
  - Geophysical
  - Landscape Context

Category	#
Herps	9
Mammals	19
Birds	33
Plants	31
Aquatic Inverts & Algae	15
Fish	12
T&E	7
Insect Pests	7
Exotic Plants	15
Exotic Animals	7
Animal/ Plant Disease	10

Decision 1: What's your Niche?

How can you describe your program scope such that you can focus on "Job 1" and do it well?

- What makes your program different than other existing monitoring efforts within your agency and others?
- How can your program complement/ supplement other monitoring efforts?
- What role is this program playing toward accomplishment of the agency mission?

Decision 2: What Type of Monitoring?

- **Trends.** Direction and variability over space and time.
- **Status / Condition.** Comparison of data at any point in time to benchmarks, thresholds, or references.
- **Effectiveness.** Evaluation of effectiveness of management actions.
- **Scenario / Risk.** Mitigating uncertainty in planning / implementation.
- **Implementation.** What actions have been taken and where.

Decision 3: What does Long-Term Mean?

- Long-term commitment to do monitoring

or

- Commitment to do monitoring the same way over the long term

Decision 4: Uses of Data

- Will you need to "roll up" data over space or time?
- Will you need to synthesize data across data sets or indicators?
- Will your data need to stand up to legal scrutiny?

Given the use, what level of rigor (accuracy, precision, power) do you need?

Decision 5: Integration of Data

Will you need to integrate data with other data sources or data sets?

- What are your explicit or known needs?
- What are your unknown needs?

What standards do you need to ensure data comparability?

Expectations

- Planning, implementation, and maintenance phases are different.
- Long-term program & planning vs. short-term accountability
  - Pressure to change methods or priorities
  - Pressure to not monitor at all
  - Pressure to deliver results in the short term
- The client-consultant trap
- Mother Nature (and Congress) don’t play nice
- Interesting findings will happen
- Data hoarding
- Resource Management & Science ≠ Monitoring Science ≠ Data Management.

Lessons Learned

- Integration of monitoring into management is harder than expected
- If you do well, you'll have unexpected/added users of your data
- Identify needs first then design a program to meet the needs
- Science must drive data management
- Do fewer things well
- You'll need to analyze data at scales larger than you expect
- Find ways to encourage creativity/ cooperation among field offices. But learn, standardize, and institutionalize wins along the way.

Top 10 Recommendations: Science

- **Don't reinvent the wheel: Use existing methods and standardize what you can**
- **Plan ahead for things to go wrong: hurricanes, fires, staff turnover, shutdowns.**
- **Keep sampling designs as simple as possible:**
  - **SBRS for spatial inference, permanent locations for temporal, combine as logical.**
  - **Limit stratification**
  - **Don't do rotating panels**
- **Document protocols, QA/QC, and procedures extensively. Someone other than you WILL be analyzing your data.**

Top 10 Recommendations: Data Mgmt

- Spend 30% of budget on data management, analysis, and reporting/communication. At a minimum.
- Centralize data.
- Don't reinvent the wheel. Leverage existing data.

Top 10 Recommendations: Admin

- Centralize the funding
- Use Boards of Directors and Steering Committees to engage stakeholders
- Plan first. Then hire.
- Have strong accountability.

Where to get more information

- National Park Service: www.nps.gov
- Natural Resource Stewardship & Science Directorate (NRSS): www.nature.nps.gov
- IMD and networks: http://science.nature.nps.gov/im
- Integrated Resource Management Applications Portal (IRMA): https://irma.nps.gov

Monitoring for Adaptive Management

BLM's National Assessment, Inventory, and Monitoring Strategy

Emily Kachergis
Landscape Ecologist
BLM National Operations Center
Denver, CO

Multi-scale land management

National Condition of Rangelands

Sage Grouse Habitat Conserv. Effectiveness

Regional Mitigation

Land Use Plan Effectiveness

Wild Horse and Burro Management

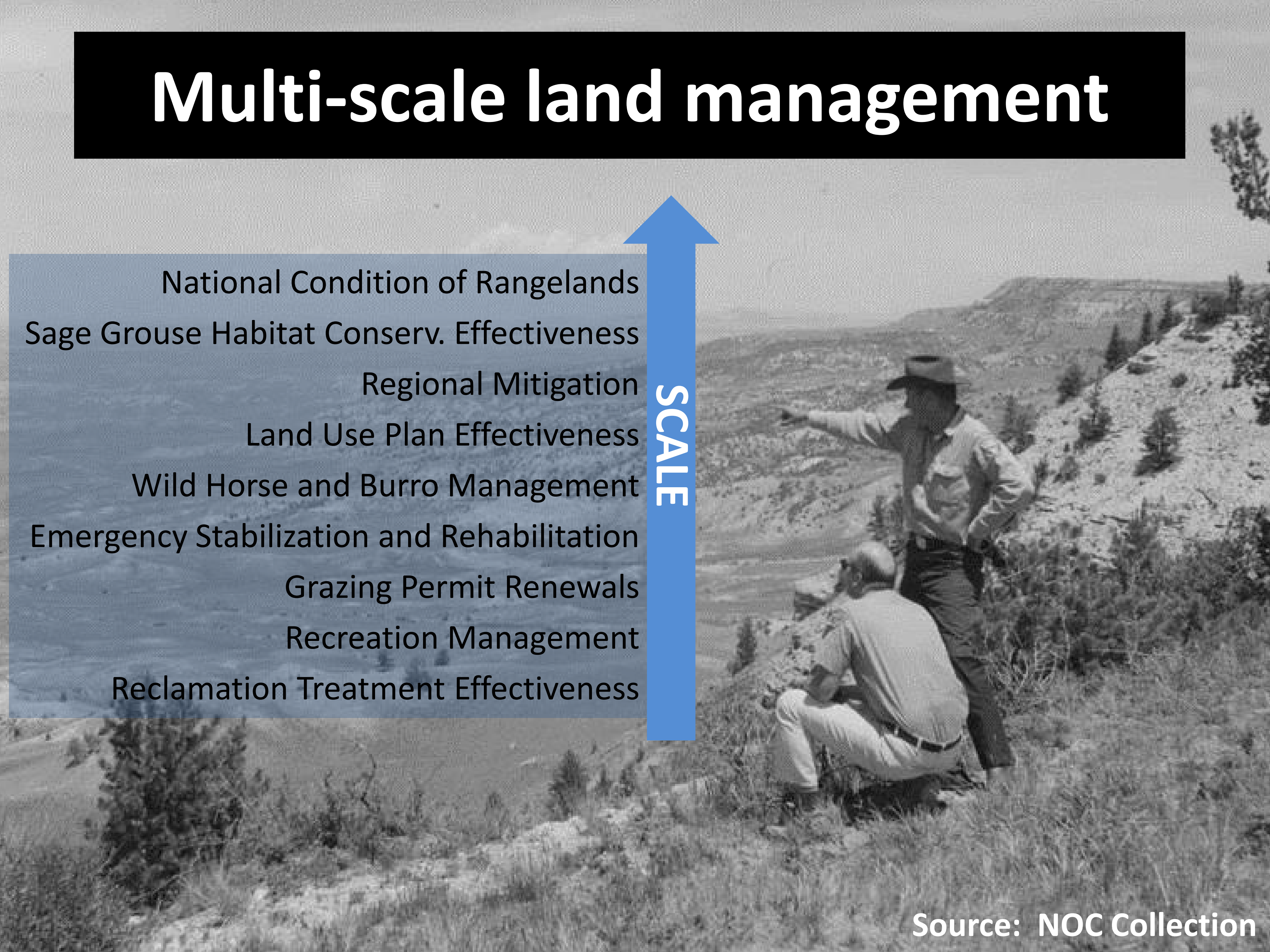
Emergency Stabilization and Rehabilitation

Grazing Permit Renewals

Recreation Management

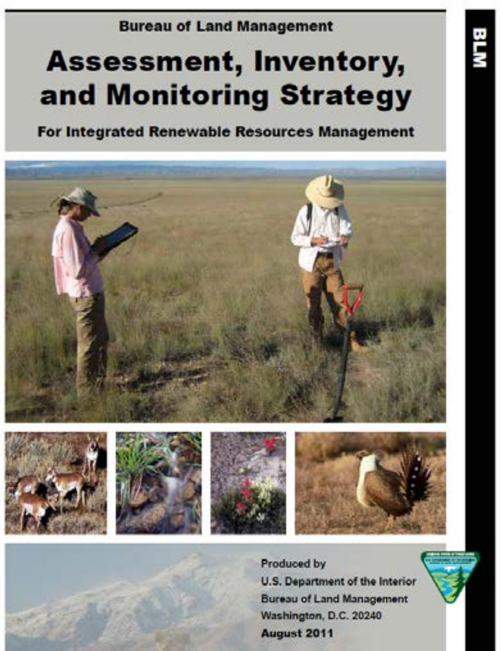
Reclamation Treatment Effectiveness

SCALE

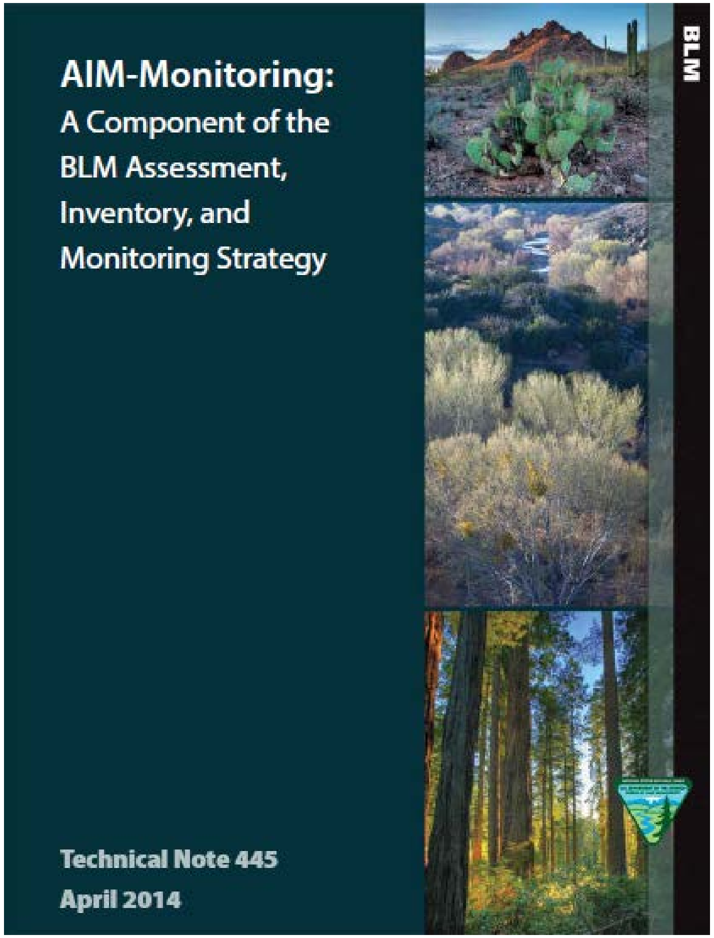


Source: NOC Collection

The goal of the AIM Strategy is to report on the status and trends of public rangelands at multiple scales of inquiry, to report on the effectiveness of management actions, and to provide the information necessary to implement adaptive management.

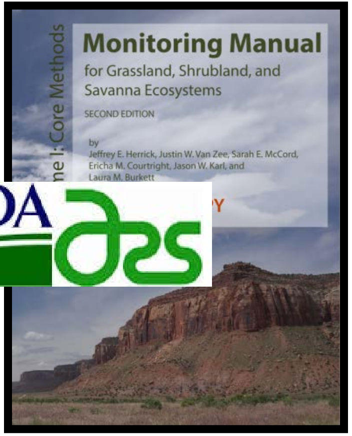


The Five Principles of AIM



- Core indicators and consistent methods
- Scalable (statistically valid) sample design, where appropriate
- Integration with remote imagery
- Electronic data capture and management
- Structured implementation — adaptive management

Core Indicators and Consistent Methods



TERRESTRIAL

Bare Ground

Vegetation Composition

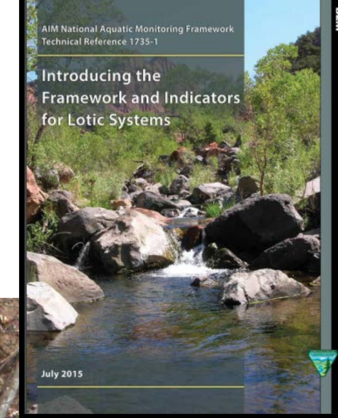
Plants of Mgmt. Concern

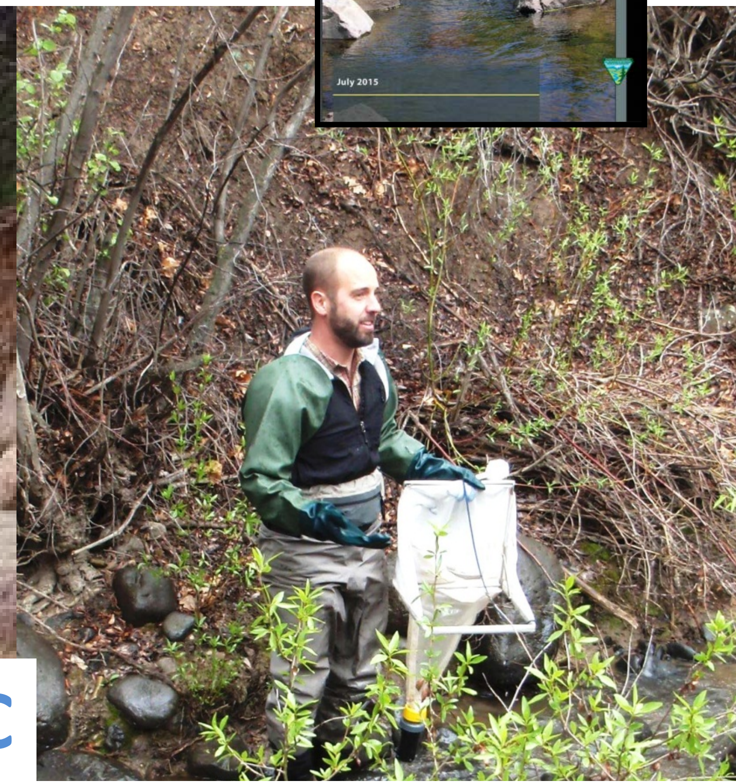
Nonnative Invasive Sp.

Height

Canopy Gaps

Core Indicators and Consistent Methods





AQUATIC

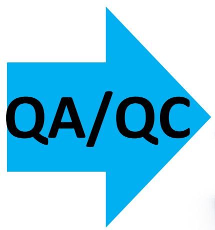
Acidity, Salinity and Temperature,

Pool Dimensions, Stream Bed Substrate, Bank Stability, Floodplain Interaction,

Macroinvertebrates, Riparian Vegetation, Canopy Cover

AIM Data Management

Electronic Data Capture



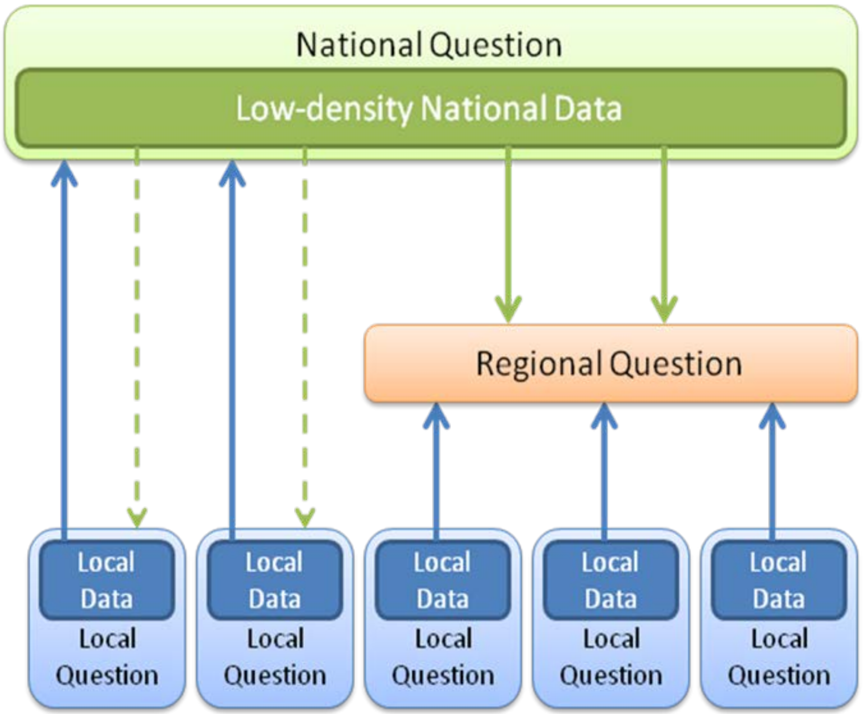
BLM National Operations Center

Seasonal Field Data Collection Teams

- Hired through 1) contract or agreement, esp. one that engages youth; 2) BLM seasonals
- Future BLM workforce
- Regional protocol trainings

Multi-Scale AIM Implementation

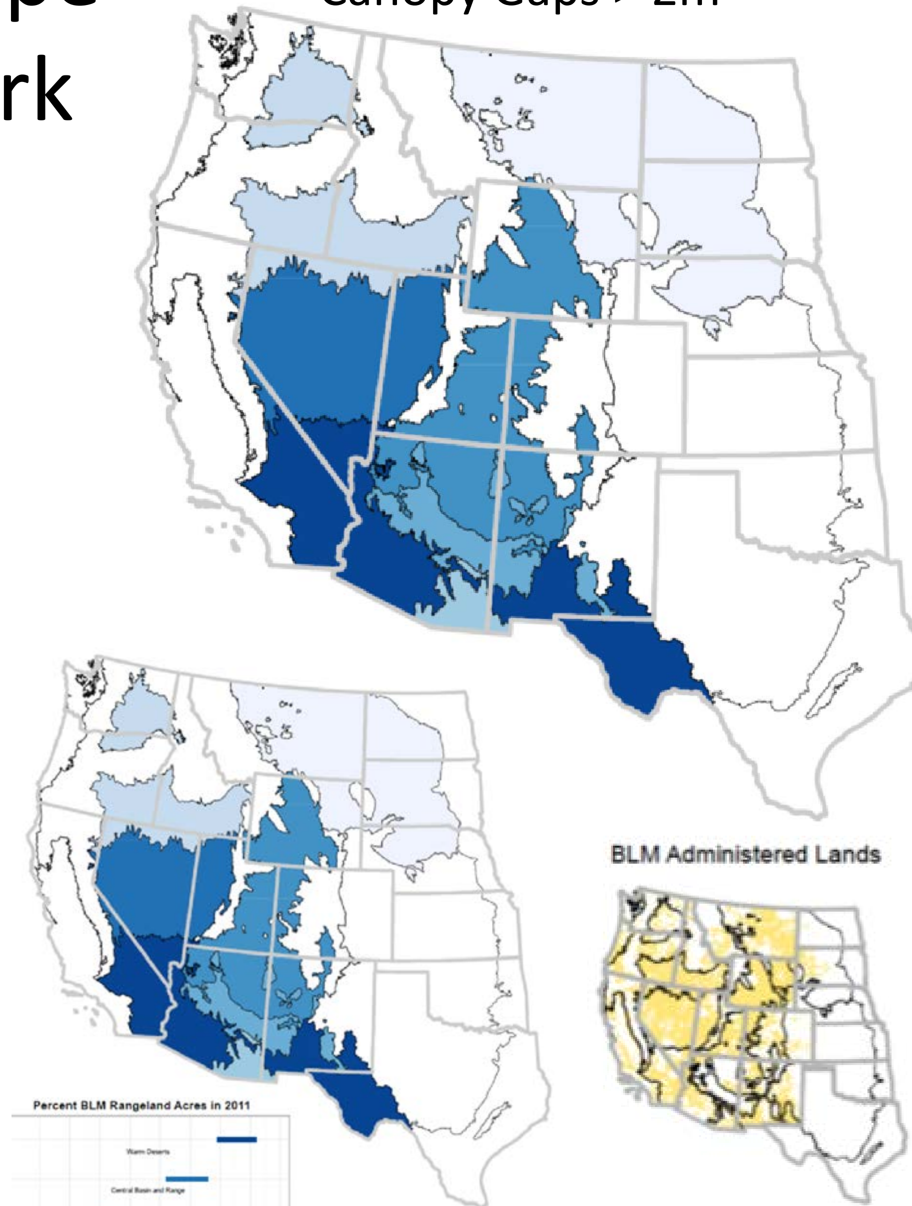
- National
  - Landscape Monitoring Framework (LMF)
- Regional
  - E.g., state assessments
- Local
  - AIM projects with BLM offices



BLM National Landscape Monitoring Framework

- Extension of NRCS NRI onto BLM Lands
- ~5,000 sites visited so far of 10,000 total
- Applications: National budget/management prioritization; sage grouse conservation strategy effectiveness

Percent of BLM Rangelands with Canopy Gaps > 2m

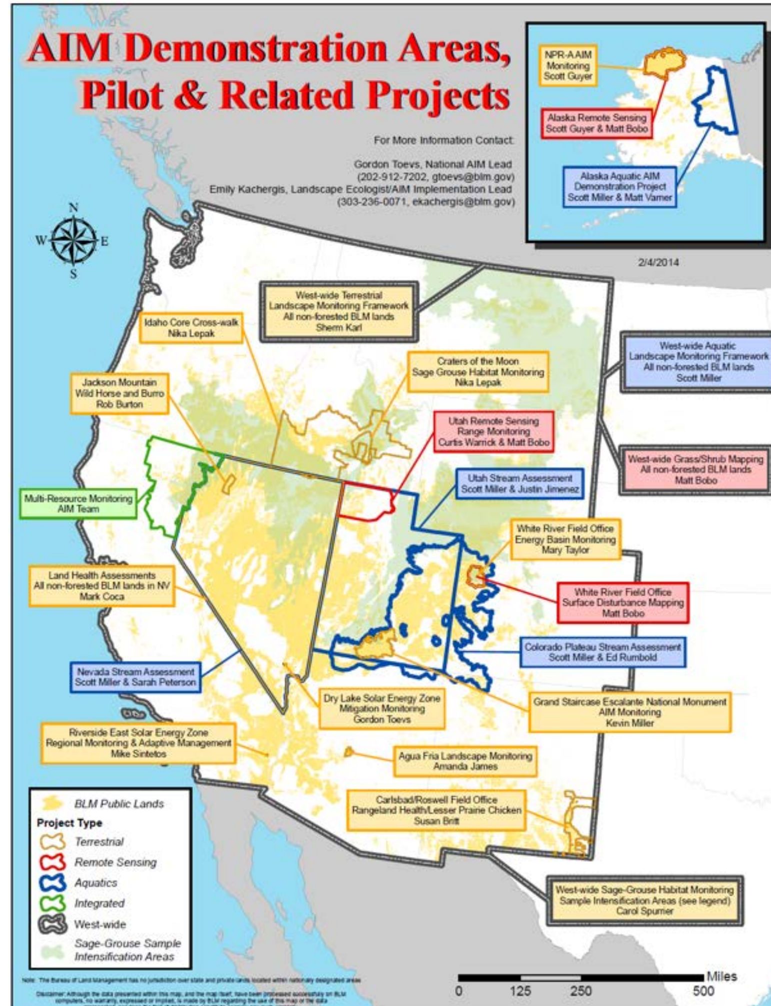


Source: 2011 BLM Rangeland Resource Assessment (*in press*)

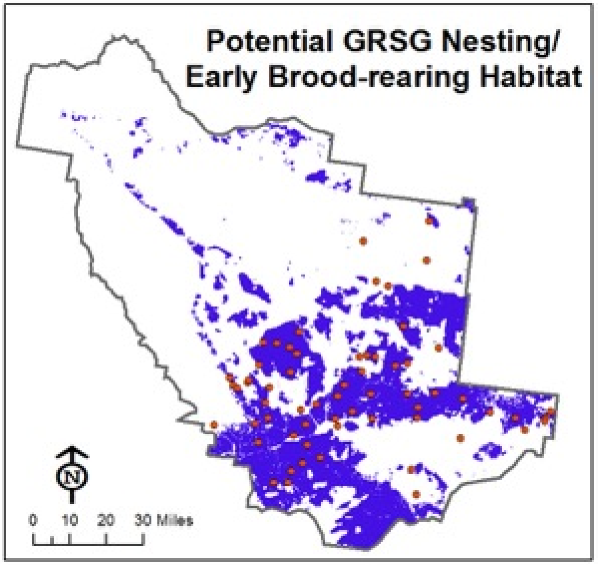
BLM Local Monitoring Efforts

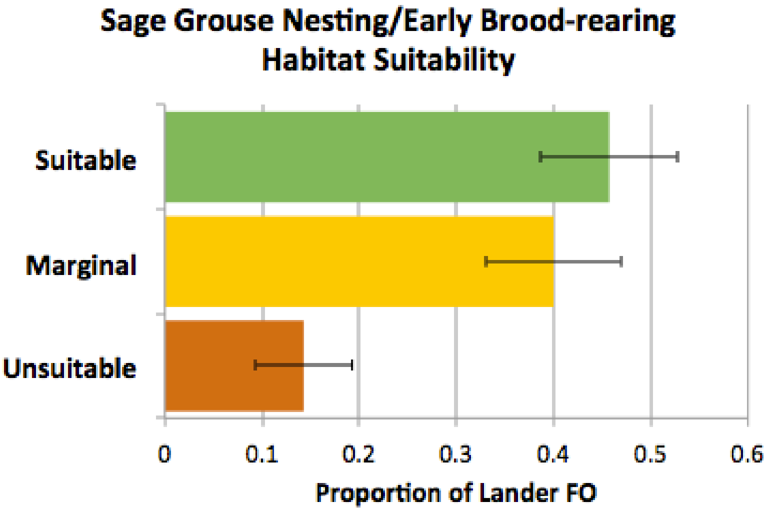
- 40+ Field Offices in 2016
- Core + supplemental methods
- Applications: Varies, locally driven

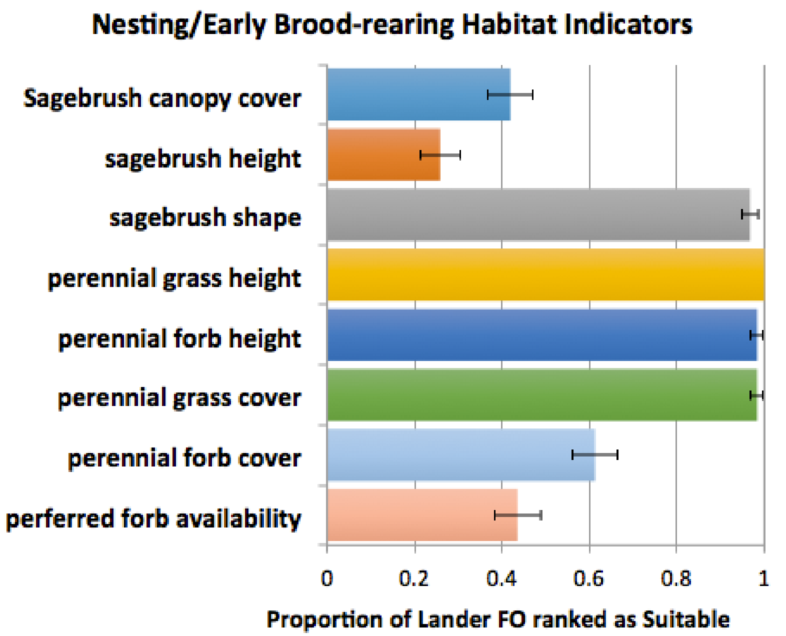




Sage Grouse Habitat



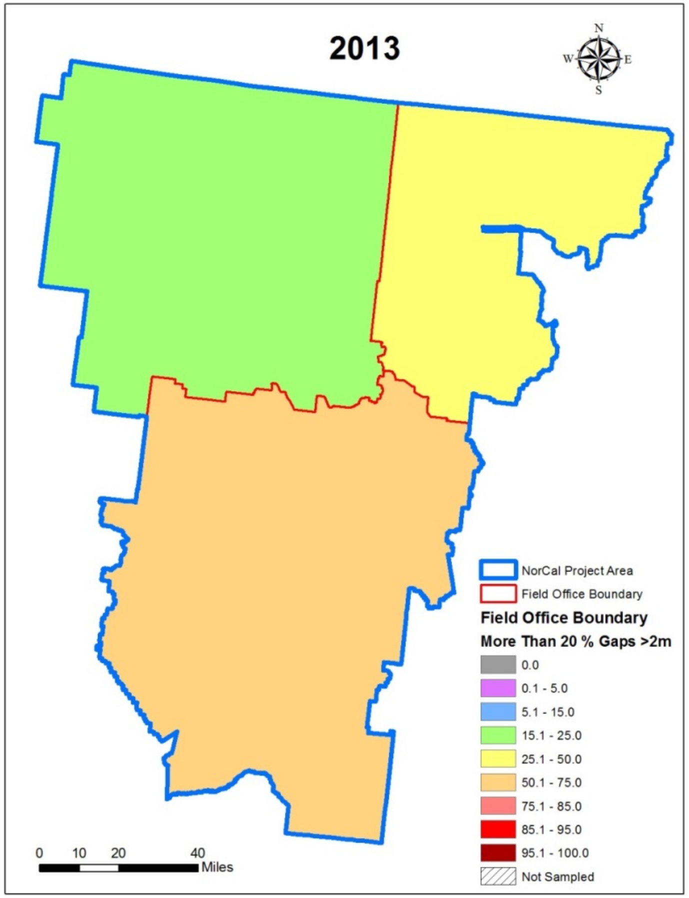




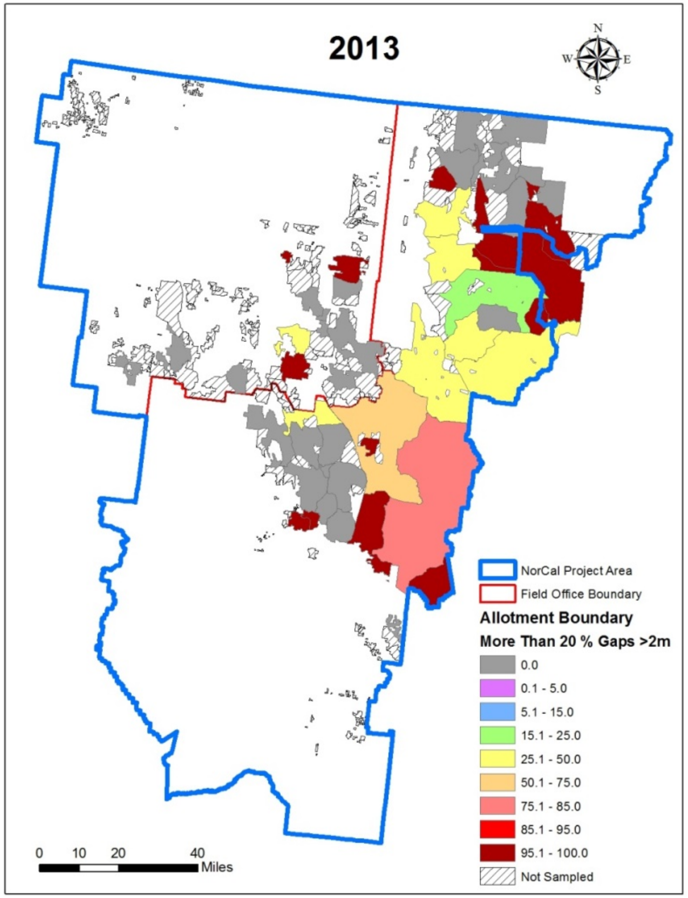
Broader Scale Provides Context for Finer Scale

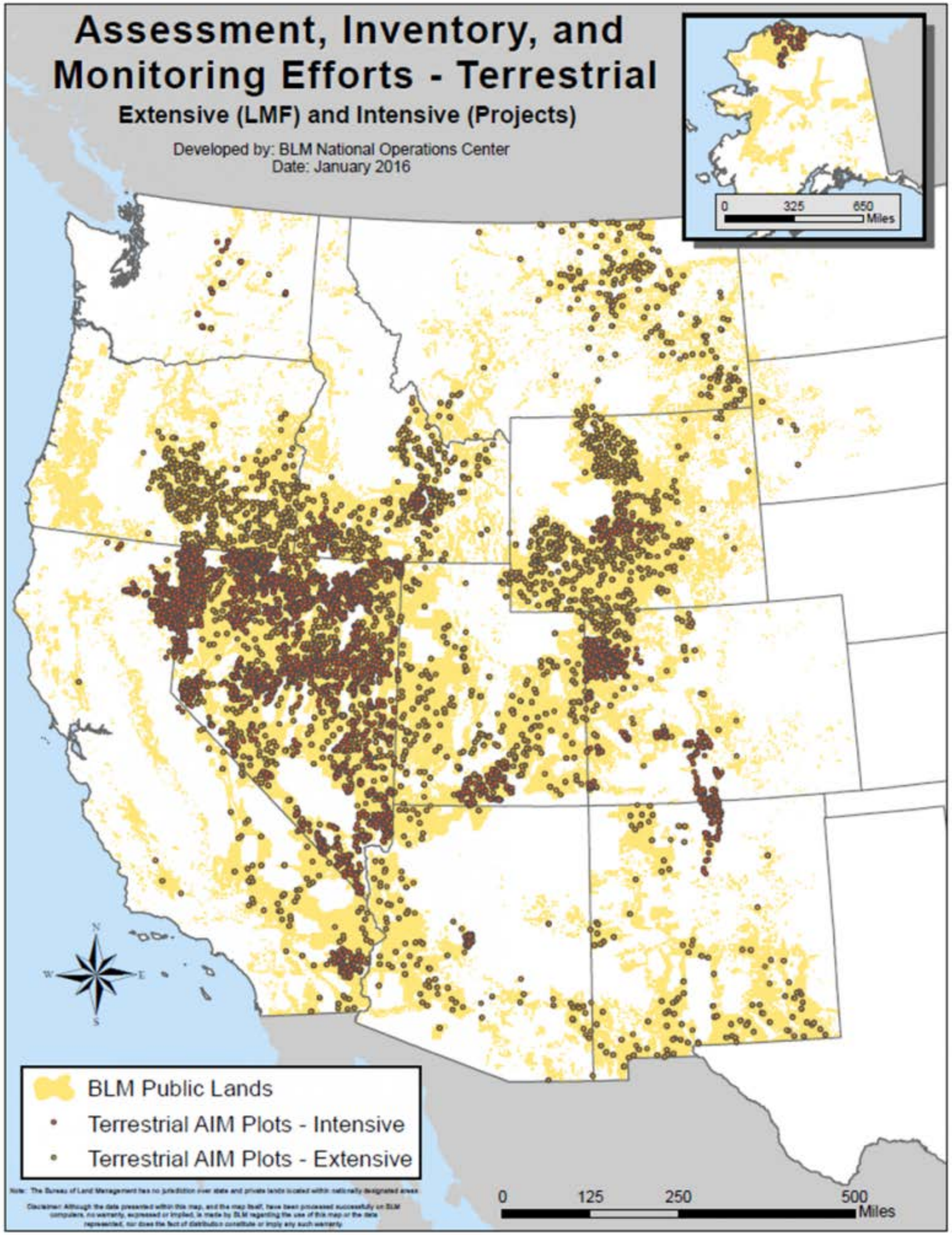
Proportion of rangelands with >20% in large canopy gaps (>2m)

Field Office



Allotment



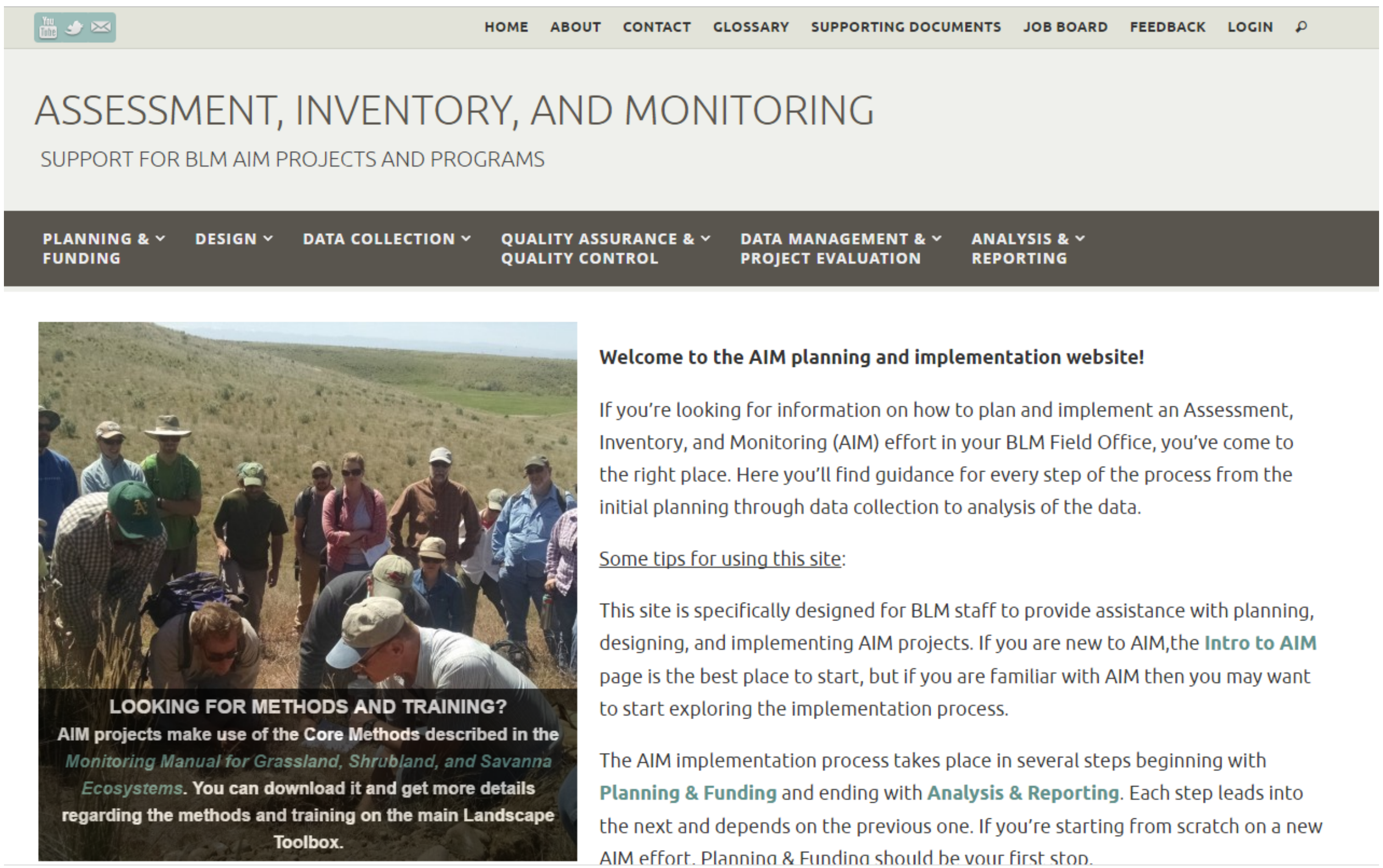


AIM Terrestrial Data to Date

Access (Public):
http://www.landscape.blm.gov/geoportal/catalog/main/home.page

For more information:

http://AIM.landscapetoolbox.org



Thanks!

National AIM Team: Gordon Toevs, Carol Spurrier, Emily Kachergis, Scott Miller, Chris Cole, Sherm Karl, Melissa Dickard, Sarah Lamagna, Sarah Burnett, Baili Foster, Jason Karl (ARS), Sarah McCord (ARS), Nelson Stauffer (ARS)

BLM AIM State Monitoring Coordinators and District/Field Office Project Leads

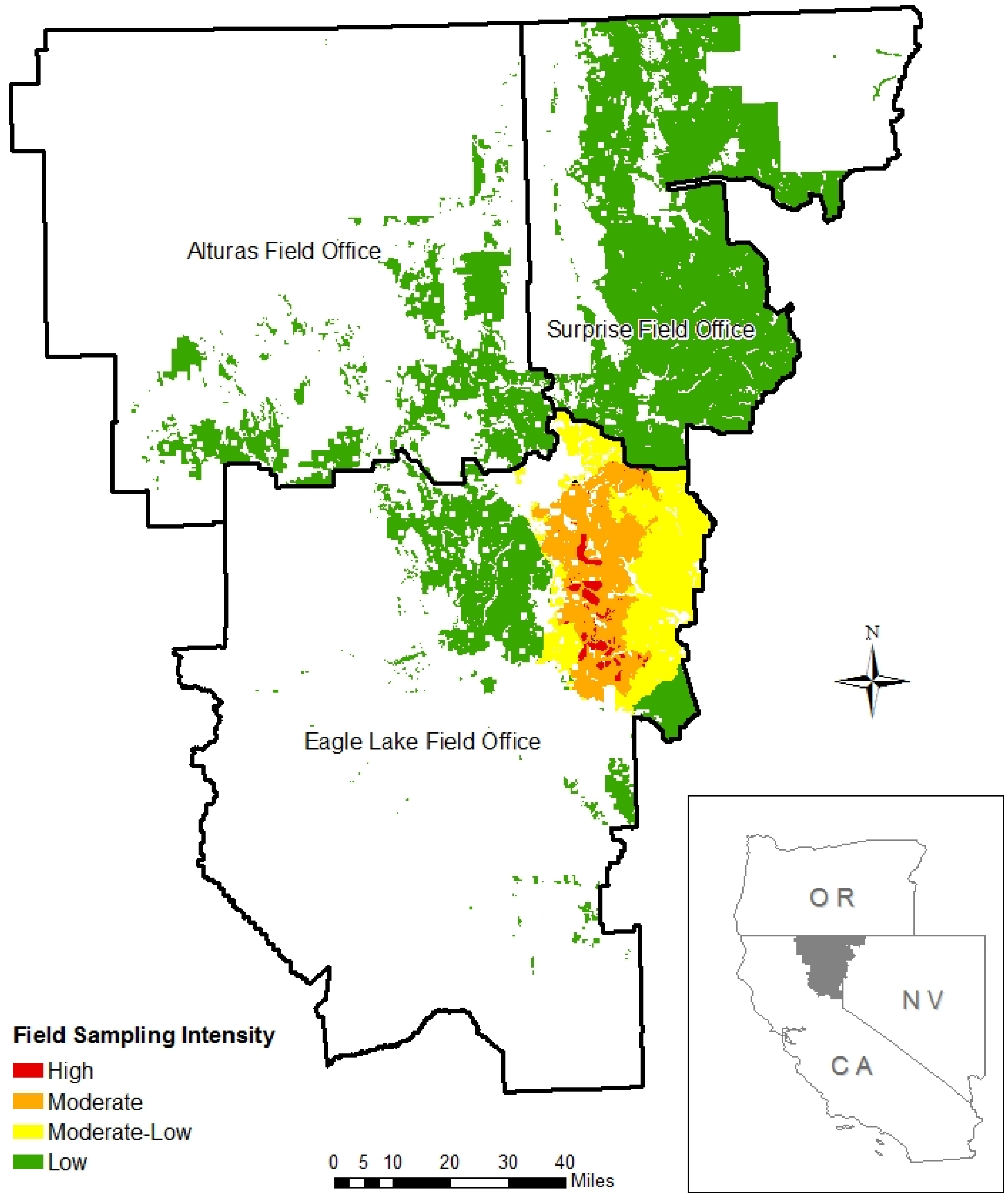
Collaborators: USDA-ARS Jornada, NRCS, USGS, Great Basin Institute, Alaska Natural Heritage Program, Iowa State University, and many more

Questions?

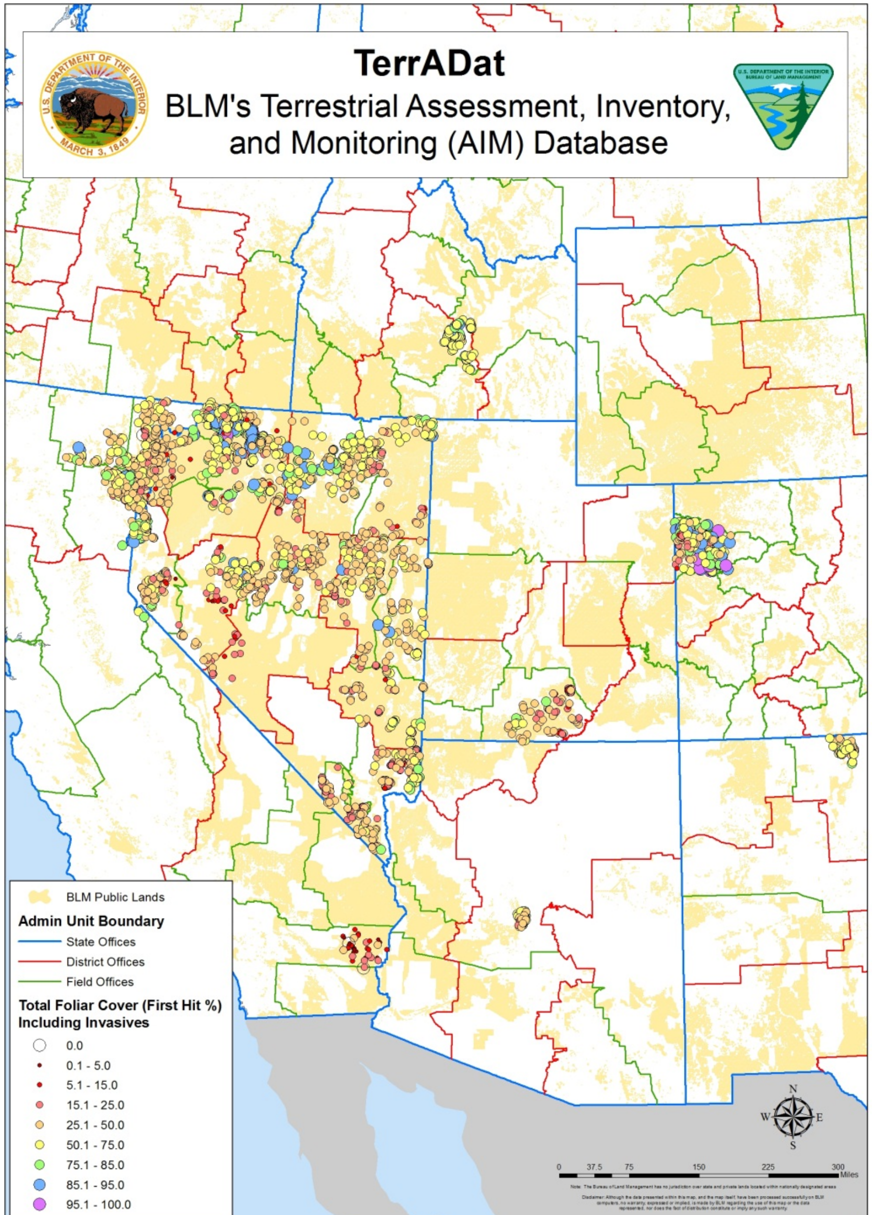
Contact: Emily Kachergis
ekachergis@blm.gov

AIM Coordinator: Gordon Toevs
gtoevs@blm.gov

Sample Design Accomodates Multiple Scales



Get Data from TerrADat



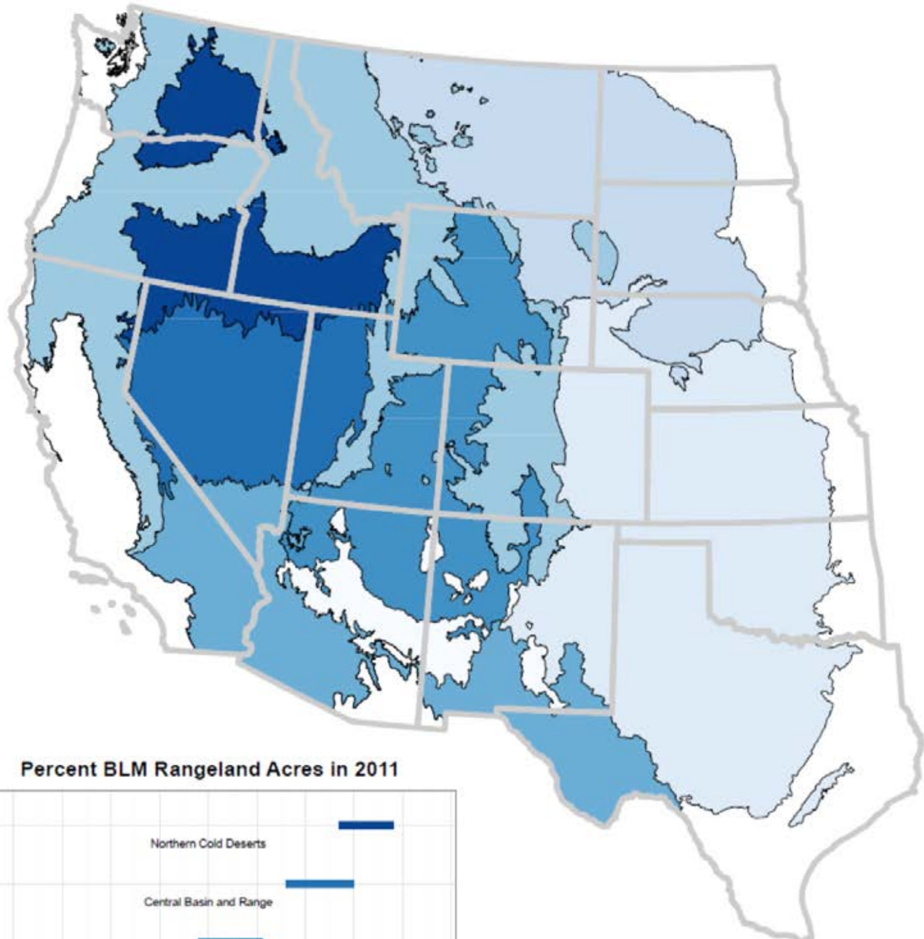
- Standard summaries
  - AIM core indicators by plot
  - Supplemental and other indicators (IIRH)
- Centralized storage
  - NOC facilitating the storage to assist in your land management decisions

BLM

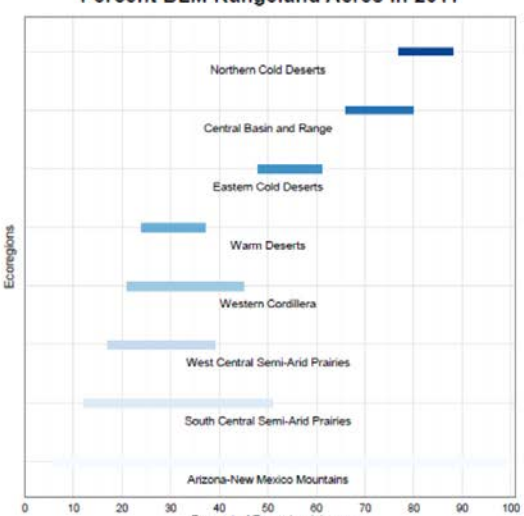
Assessment, Inventory, and Monitoring (AIM) Strategy

West-Wide Landscape Monitoring Framework

BLM Rangeland with Presence of Non-Native Invasive Plant Species



Percent BLM Rangeland Acres in 2011



BLM Administered Lands

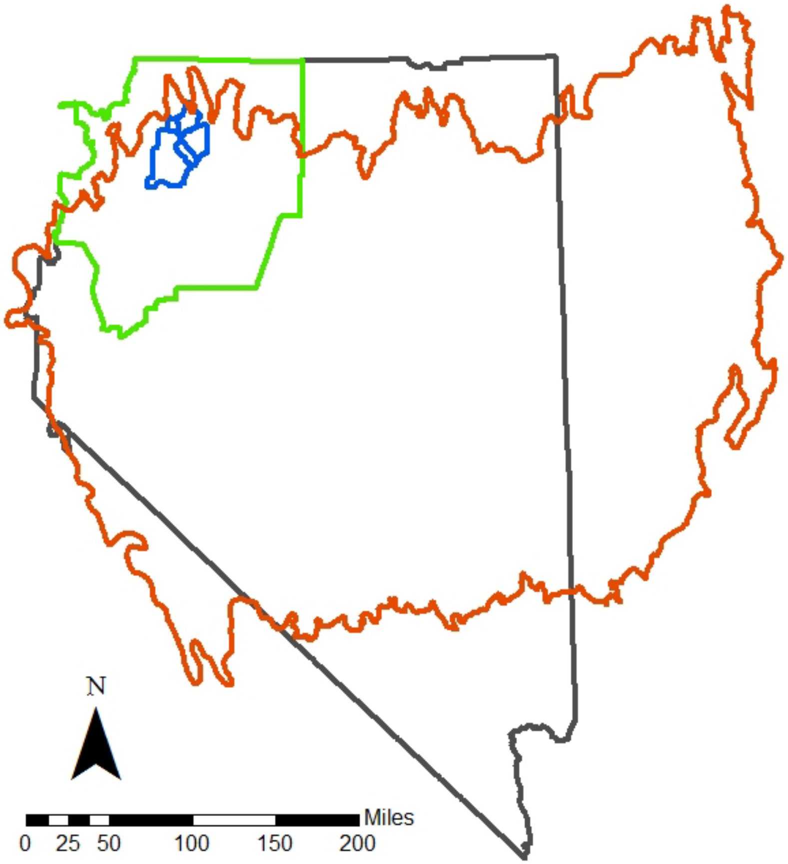
U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

NRCS

IOWA STATE UNIVERSITY

USDA ars

AIM is…



…statistically valid, scalable sampling design

Broader-Scale Monitoring Strategy Workshop:

Ideas for rangeland monitoring

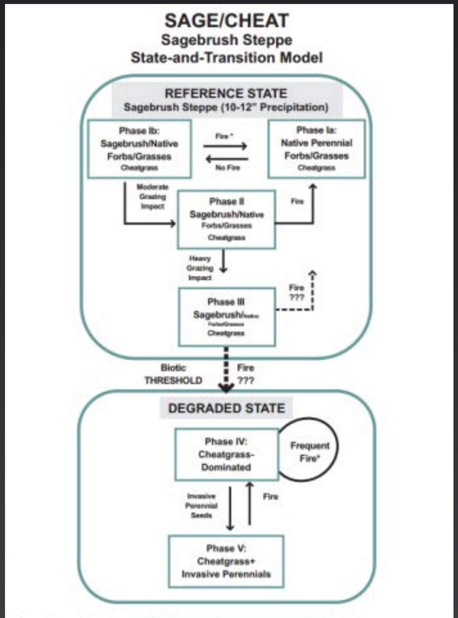


Figure 2. State-and-transition model for the sage/cheat system (10- to 12-inch precipitation zone) focusing on vegetation only. (See Table 2 for site differences in vegetation, soils, and other inherent site features.) Font size indicates relative dominance of vegetation life form within each phase. *Fire is assumed to be severe enough to kill most of the woody vegetation.

April 28, 2016

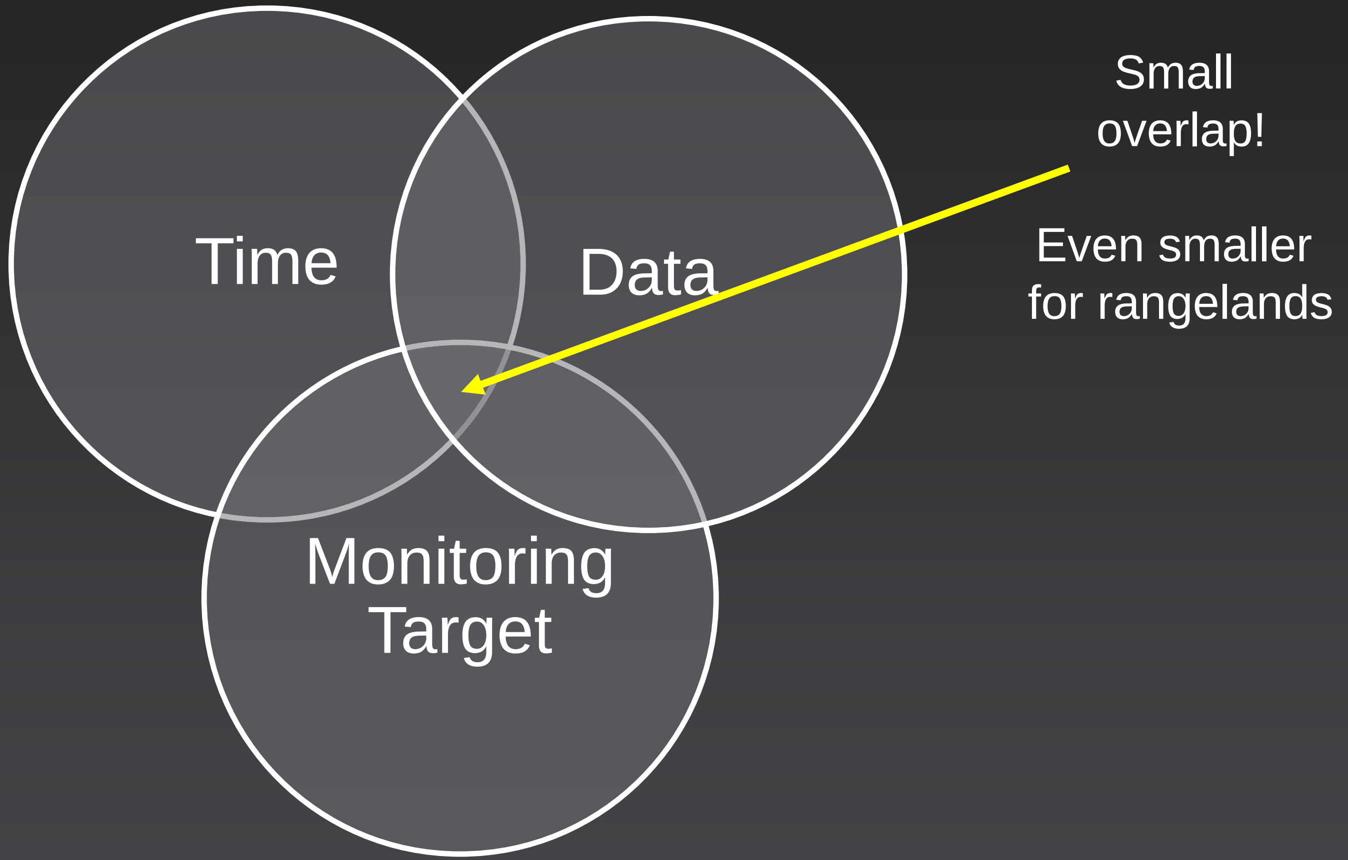
Matt Reeves

USDA, USFS, RMRS

Considerations for broadscale monitoring

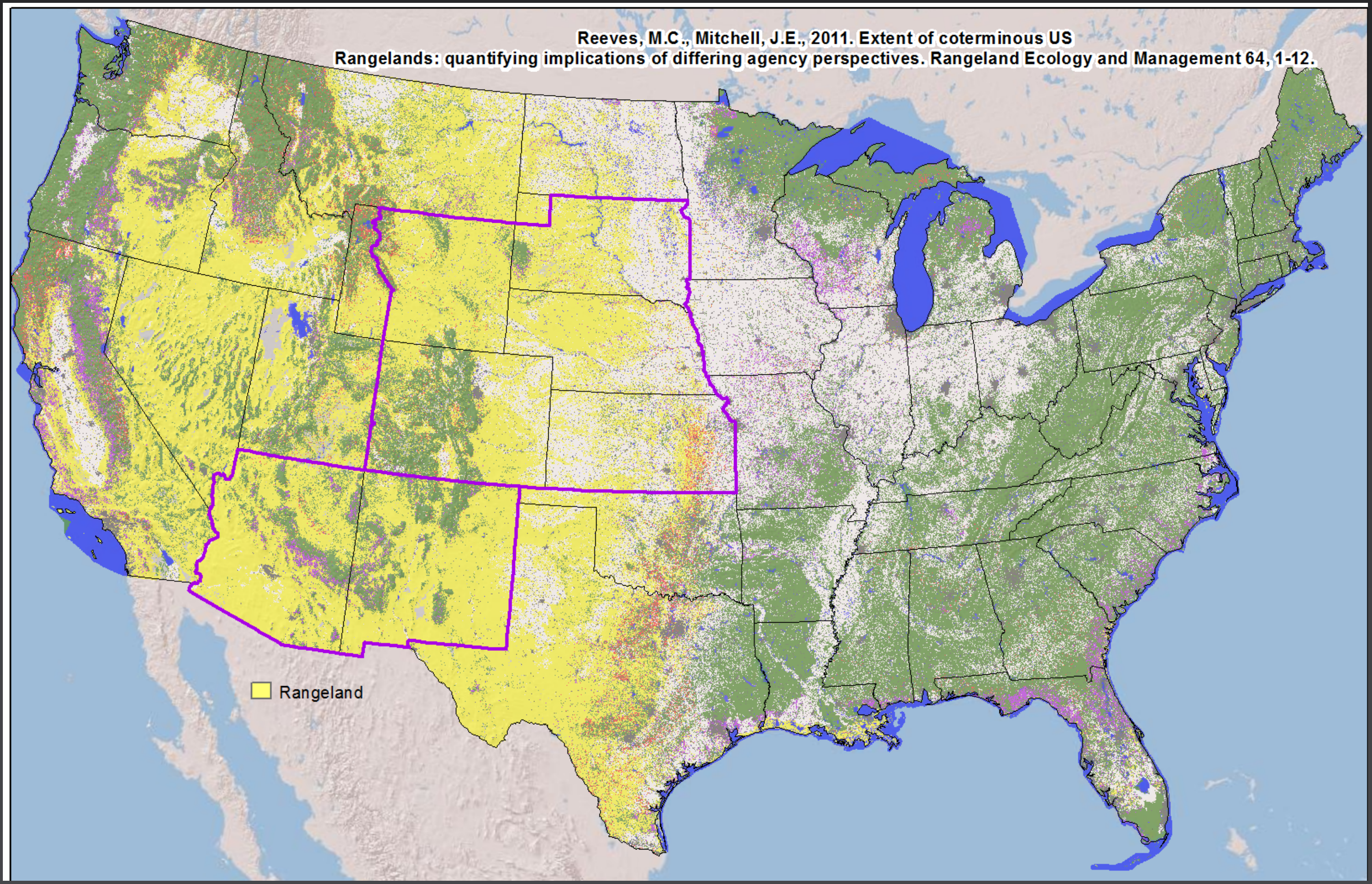
- What to monitor?
- Over what time frame?
- Why are you interested in monitoring that:
  - Planning Rule Requirement?
  - Recovery of allotment after wildfire?

Considerations for broadscale monitoring



Considerations for broadscale monitoring

Define your base:



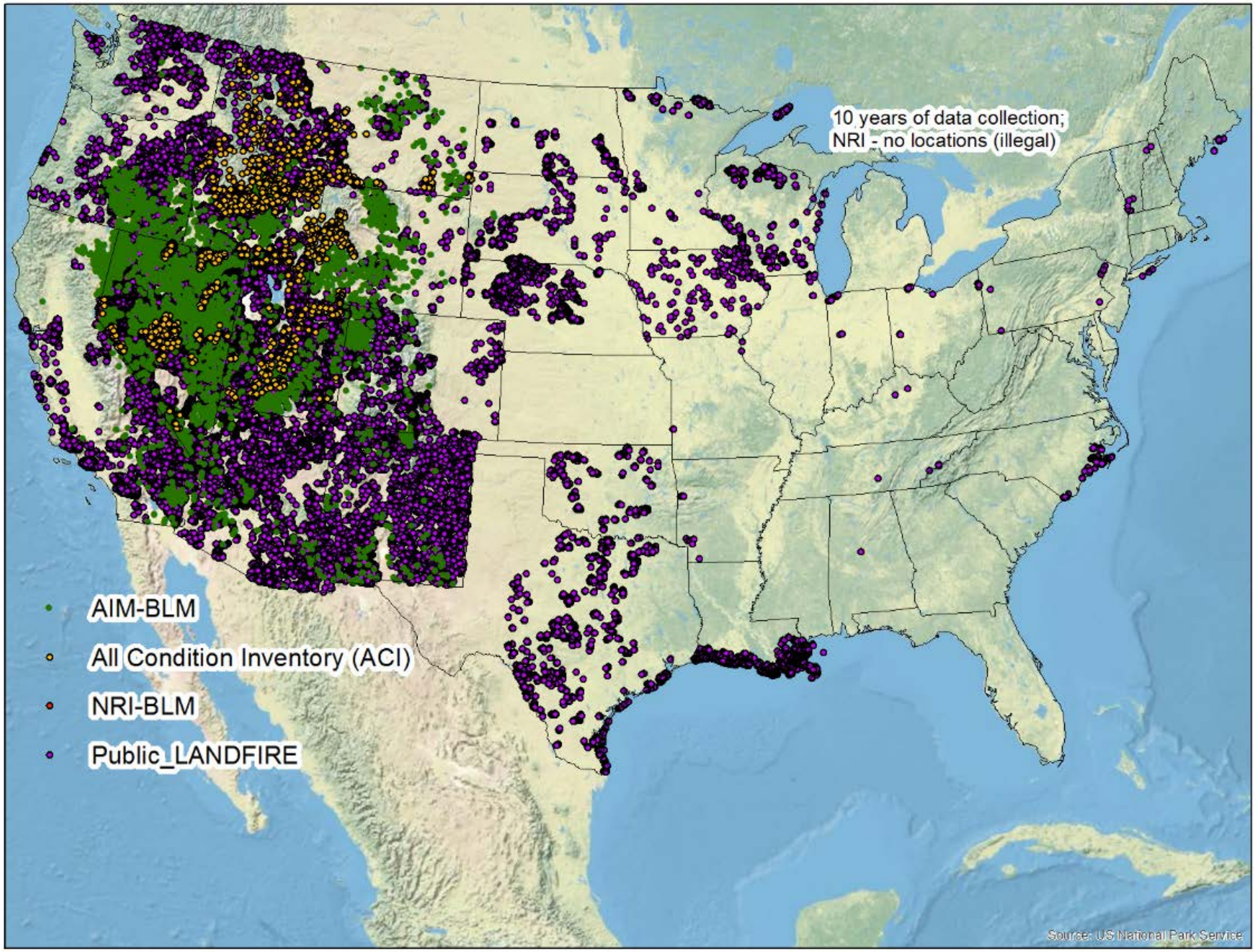
Considerations for broadscale monitoring

Examples of data in the "toolbox"

Baseline Data	Time Series	State Variables
Existing Vegetation Type	NDVI (Weekly)	Soil Organic Carbon (Stored) SSURGO Statsgo NASIS- Enhanced
Existing Vegetation Height	NPP (Annual)	??
Existing Vegetation Cover	Drought monitor (weekly)	??
Biophysical Settings	Forage production (Weekly, seasonal, Annual)	??
Ecological Sites	Stubble Height (Weekly, seasonal, Annual)	??
TEUI	Permitted/authorized (FS data)	??
NFRD	MTBS	??
PADUS	Invasives maps (Bugwood)	??
VCMQ	Soil Organic Carbon (SOC) Flux?	??

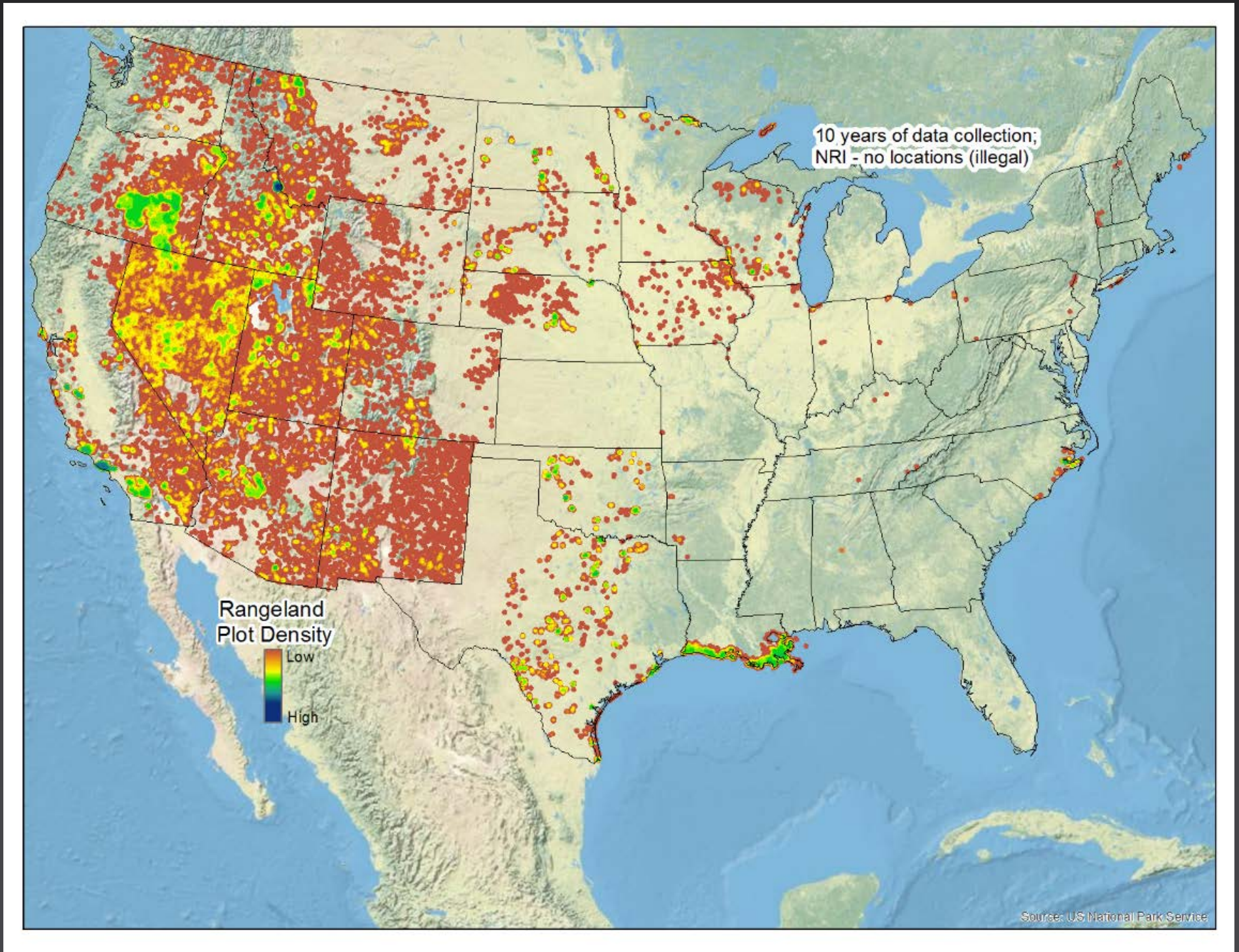
Considerations for broadscale monitoring

Time series data critical and rare



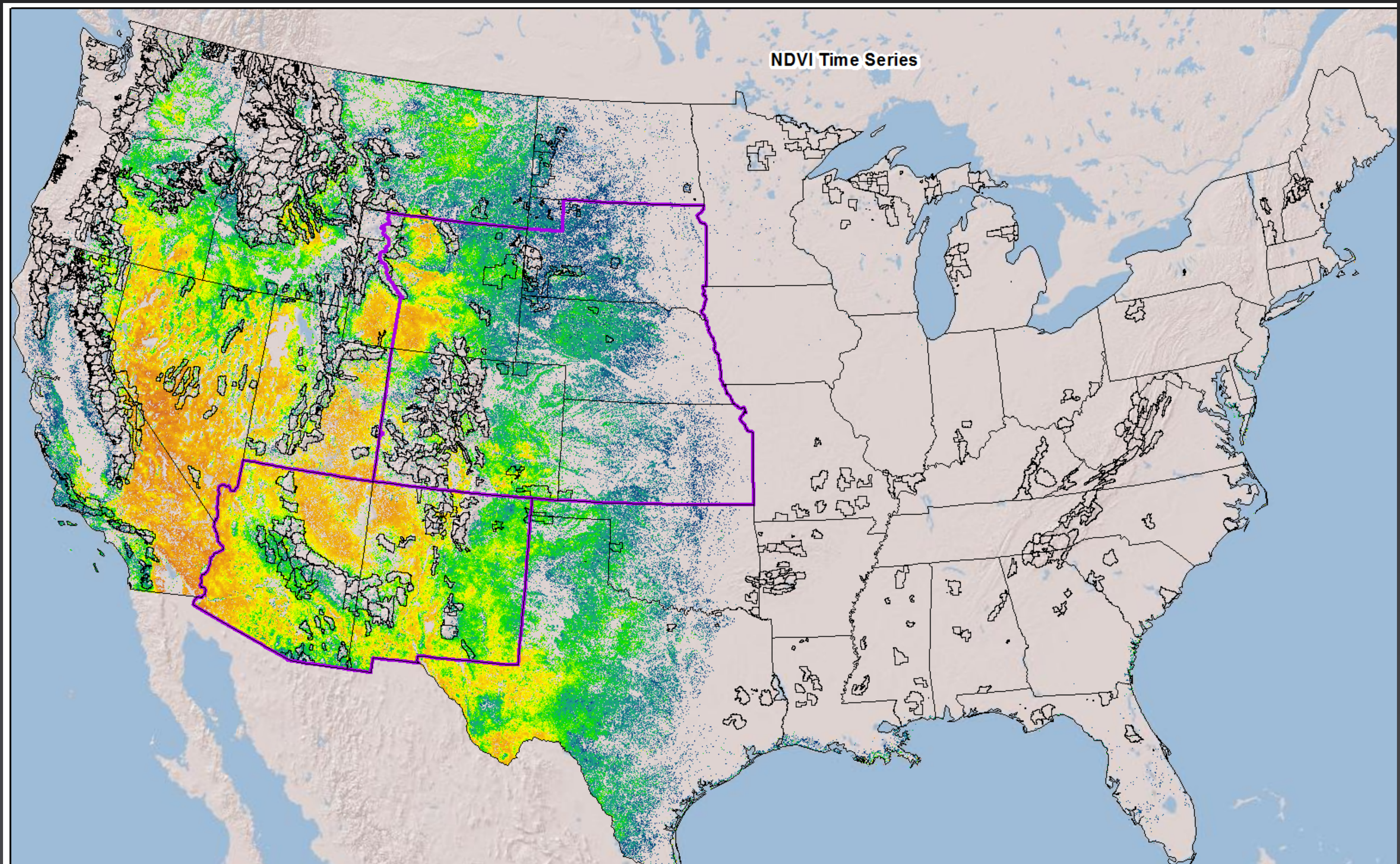
Considerations for broadscale monitoring

Time series data critical and rare

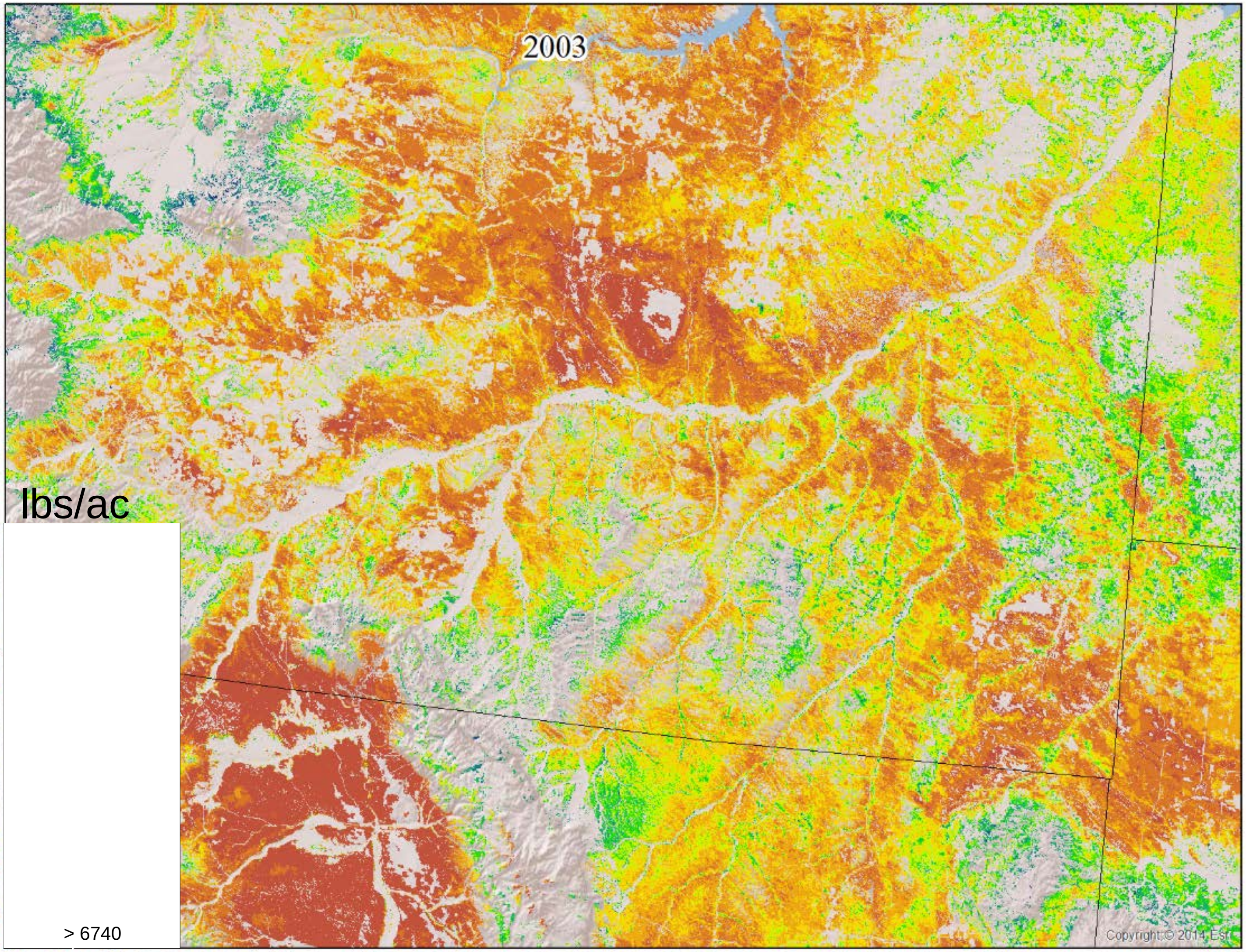


Considerations for broadscale monitoring

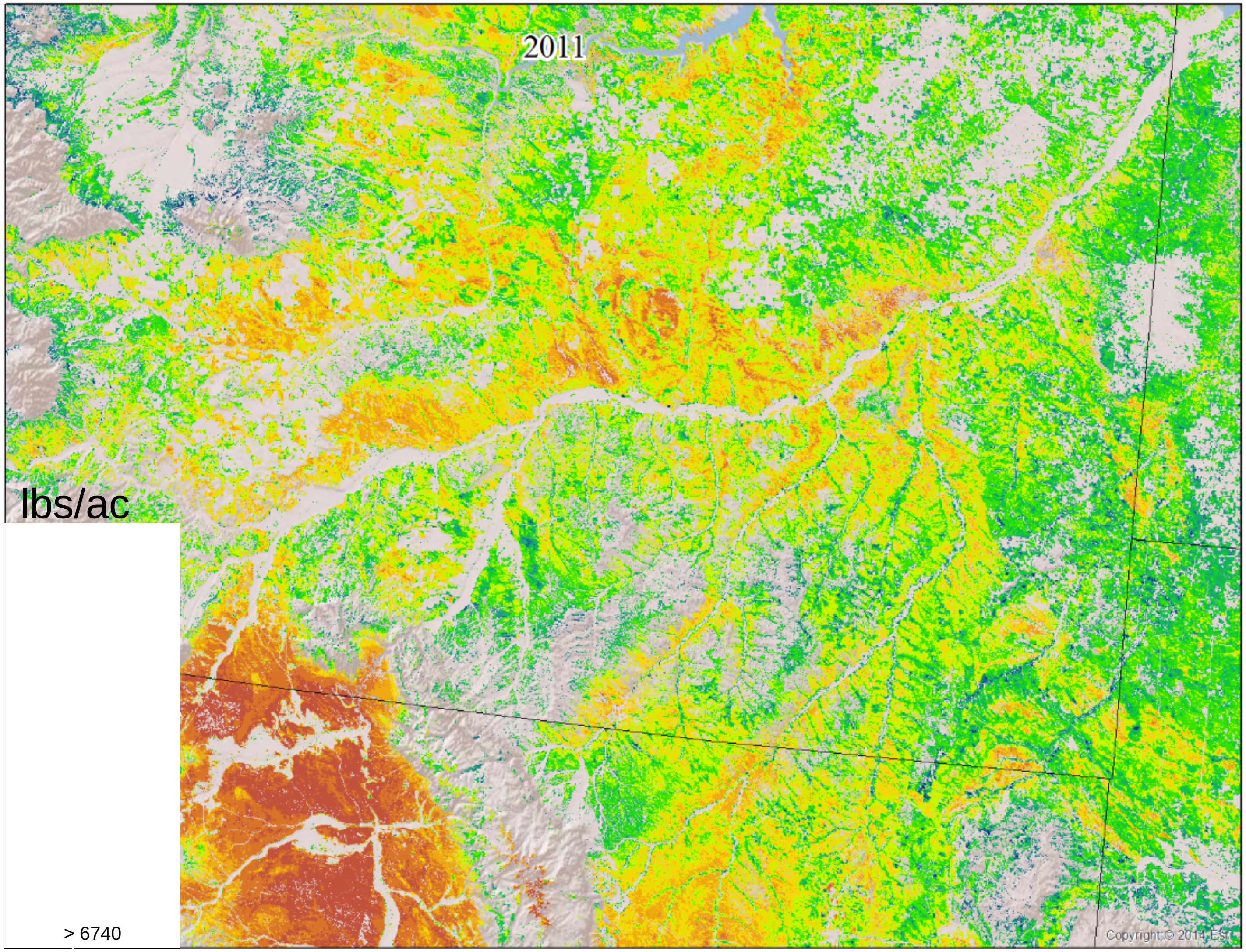
Time series data critical and rare



Considerations for broadscale monitoring



Considerations for broadscale monitoring

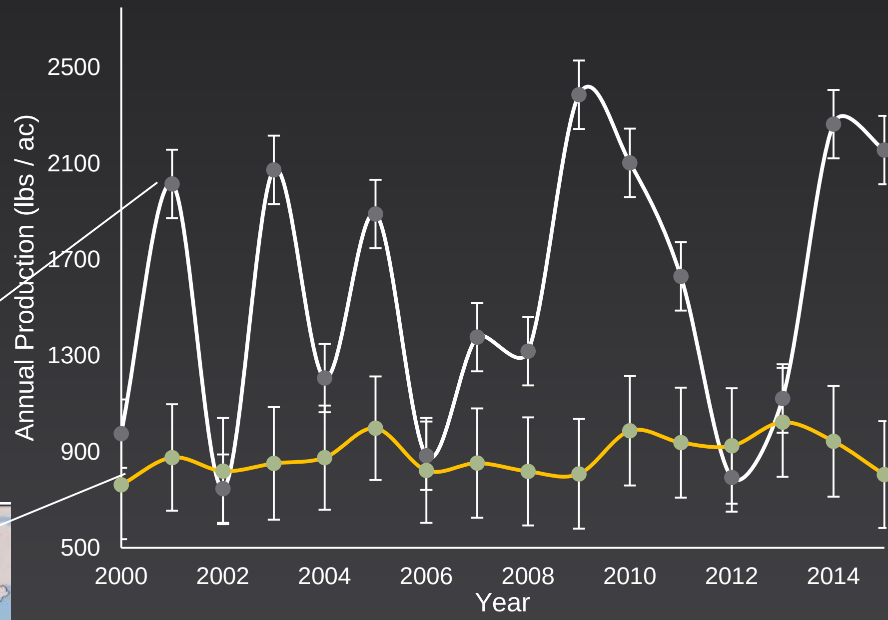


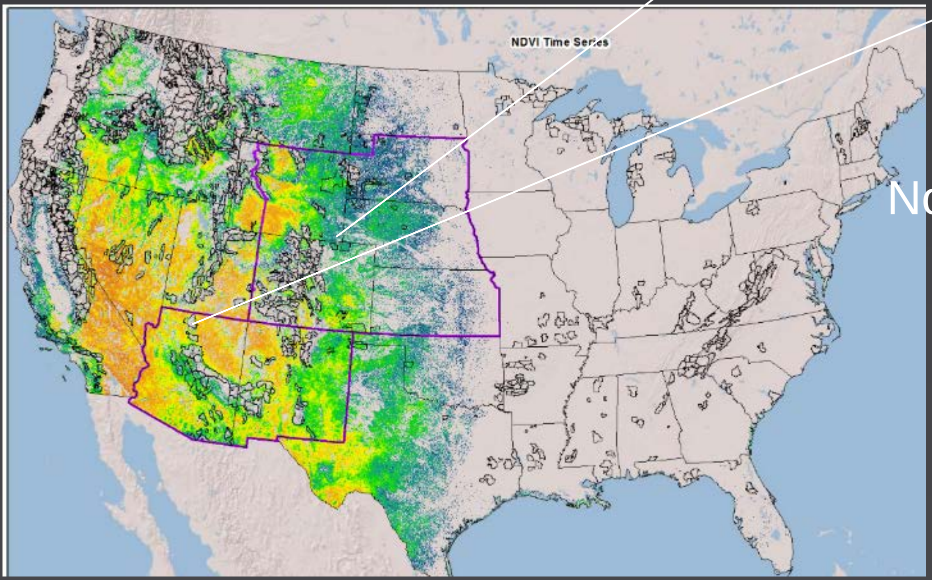
Considerations for broadscale monitoring

Time series data critical and rare

Allotment monitoring:
This is underutilized!

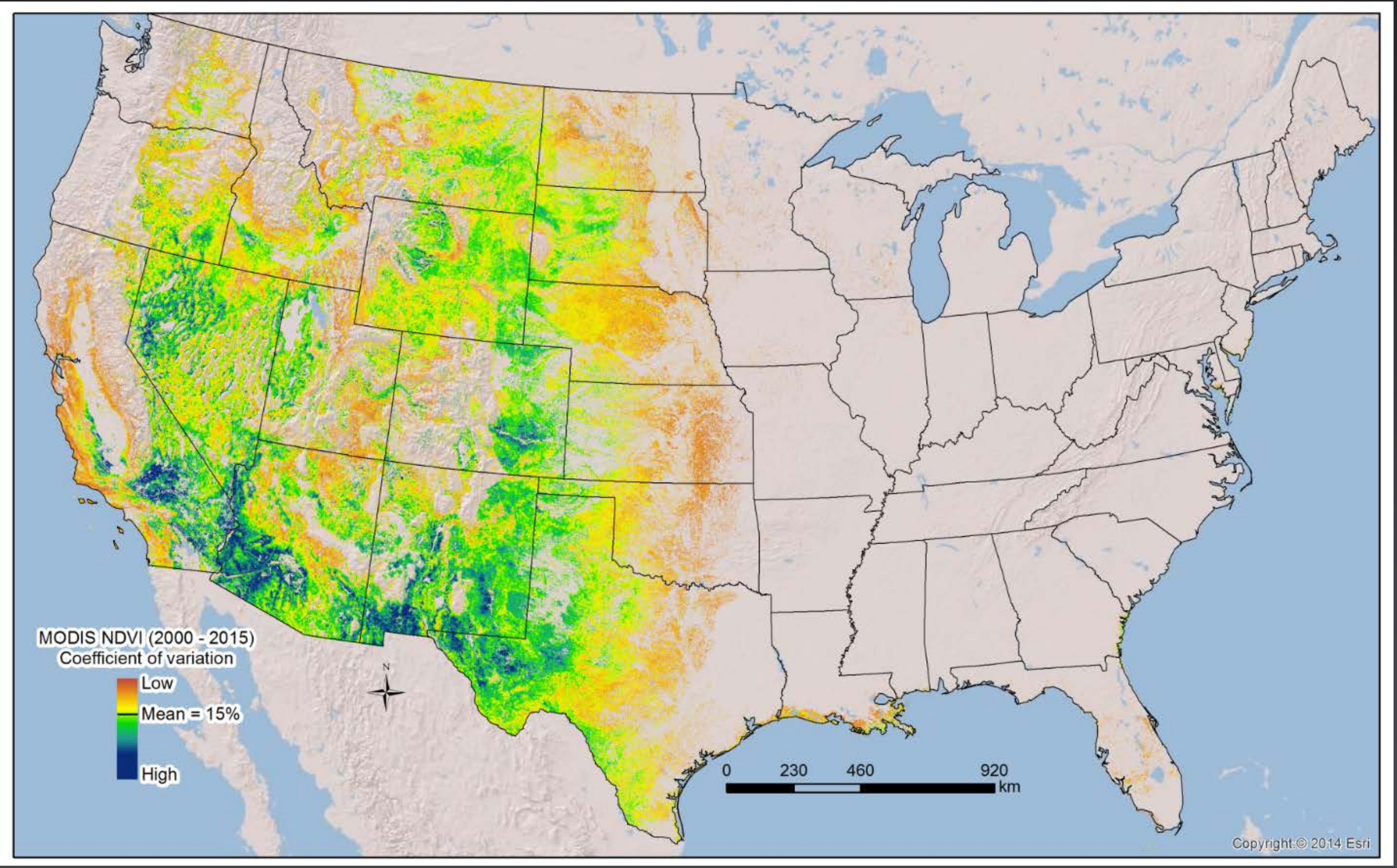
Pawnee RD



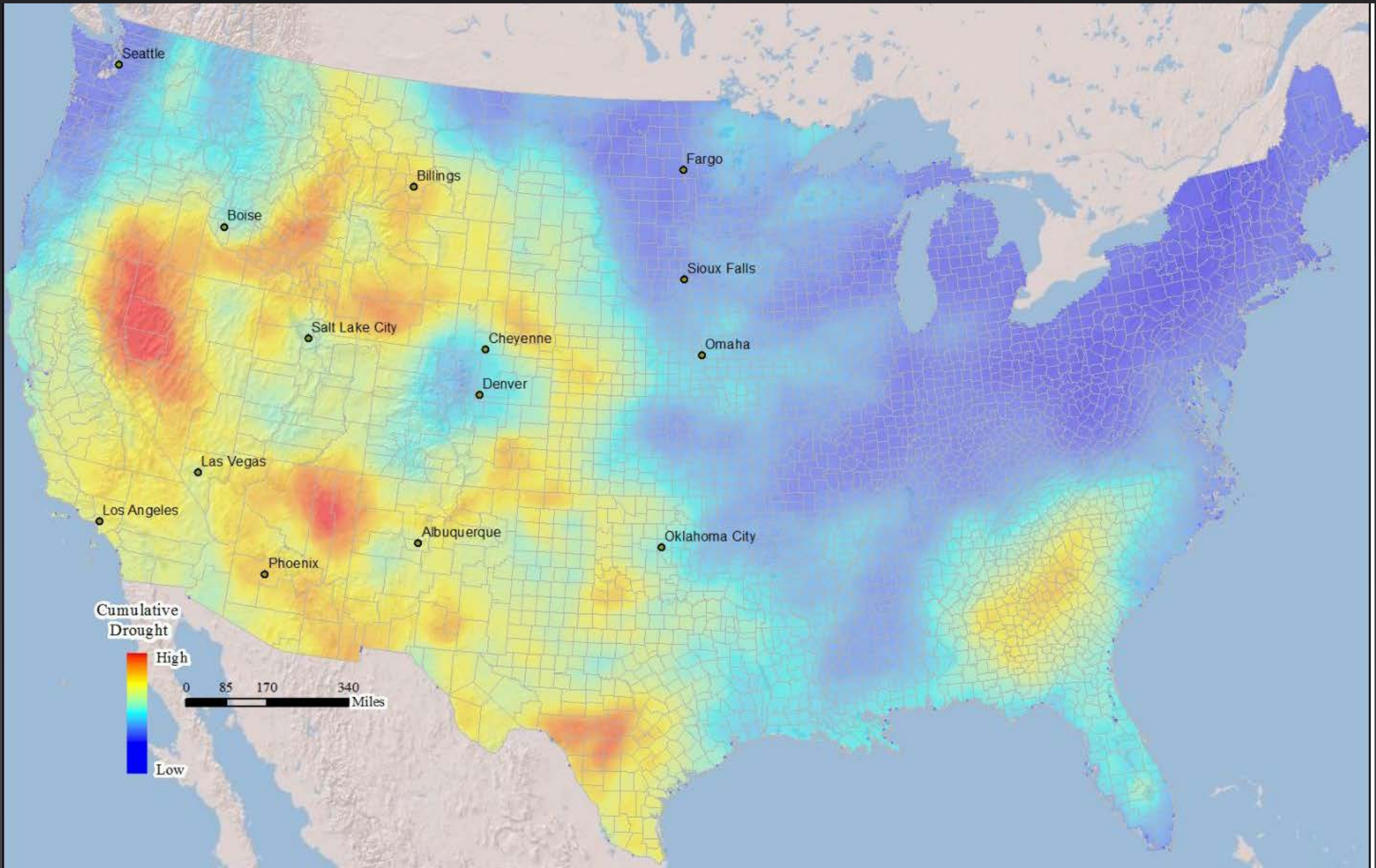


North Kaibab RD

Focus on variability?

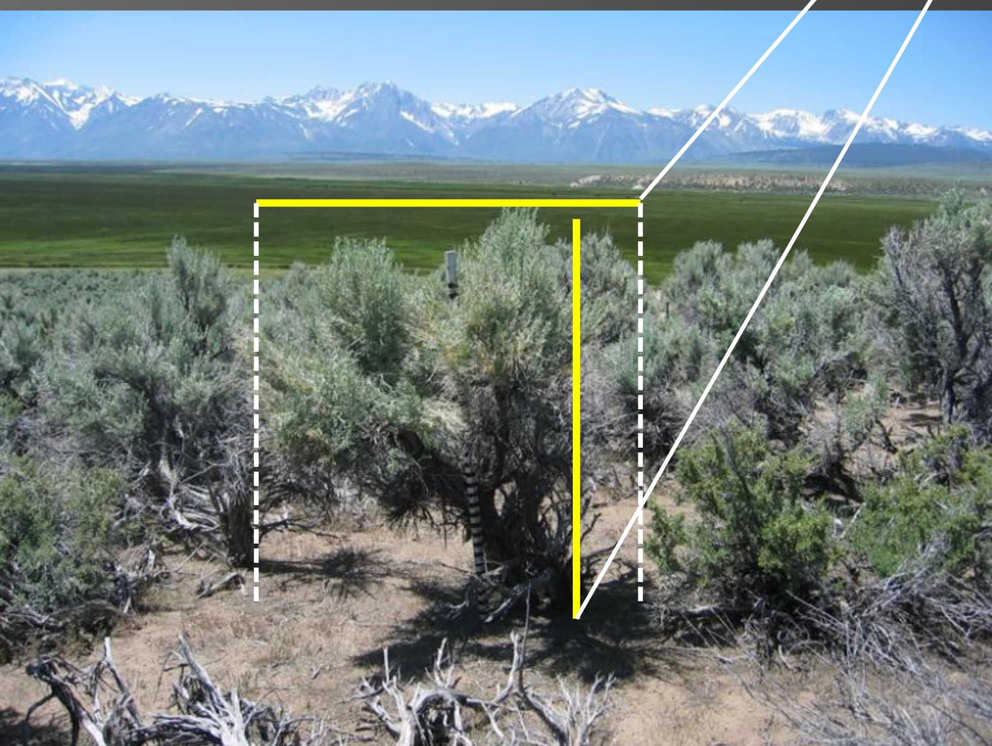


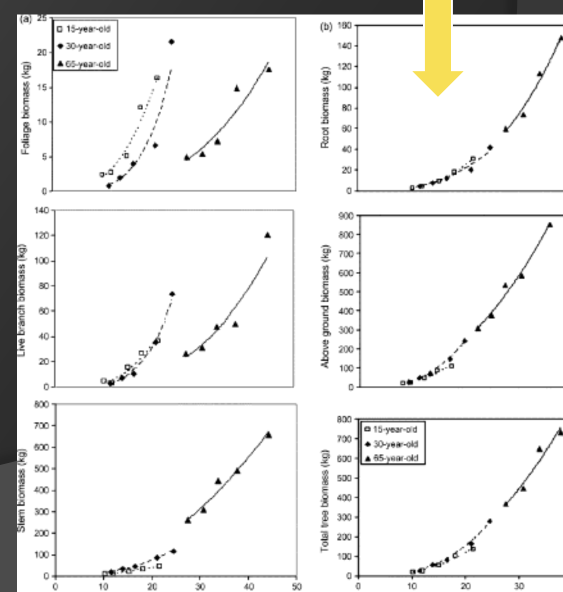
Drought


Seattle
Billings
Fargo
Boise
Sioux Falls
Salt Lake City
Cheyenne
Omaha
Denver
Las Vegas
Los Angeles
Albuquerque
Oklahoma City
Phoenix
Cumulative Drought
High
Low
0 85 170 340
Miles

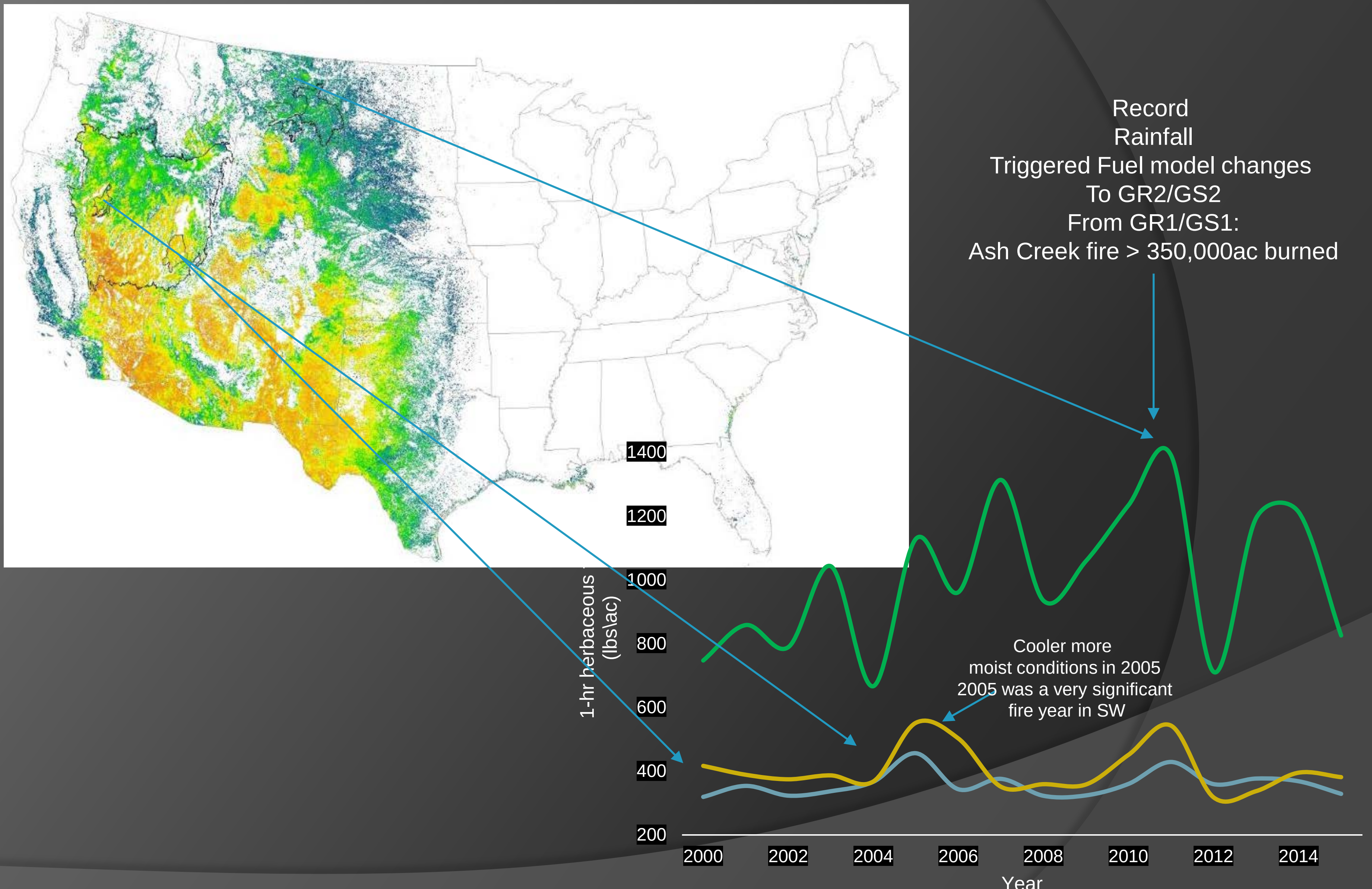
Fuels / above ground carbon

Acer circinatum	ln(BFT) = 1.8820 + 1.9754 * ln(DBA)
Artemesia tridentata	BFT = 43.0 + 0.0907 * VOL
Castanopsis chrysophylla	ln(BFT) = 2.6399 + 1.8902 ln(DBA)
Ceanothus velutinus	ln(BAT)= 6.52746 +0.003278*LEN -0.05195*(DBA)^2 +3.095*(DBA)^0.5
Corylus cornuta	ln(BFT) = 2.4170 + 2.040 * ln(DBA)
Holodiscus discolor	ln(BFT) = 2.1600 + 1.982 * ln(DBA)
Oplopanax horridum	ln(BFT) = 1.45 + 2.11 * ln(DBA)
Rhododendron macrophyllum	ln(BFT) = 2.6560 + 1.8268 * ln(DBA)
Ribes bracteosum	ln(BFT) = 2.2116 + 2.0127 * ln(DBA)
Rubus spectabilis	ln(BFT) = 2.4667 + 2.6596 * ln(DBA)
Salix sitchensis	ln(BFT) = 2.1706 + 2.5593 * ln(DBA)
Vaccinium alaskaense	ln(BFT) = 1.5368 + 2.3086 * ln(DBA)
Berberis nervosa	BFT = 14.218 + 1.984 * COV
Gaultheria shallon	ln(BFT) = 1.5457 + 0.7026 * ln(COV)
Castanopsis sempervirens	BAT = 9.19 * COV

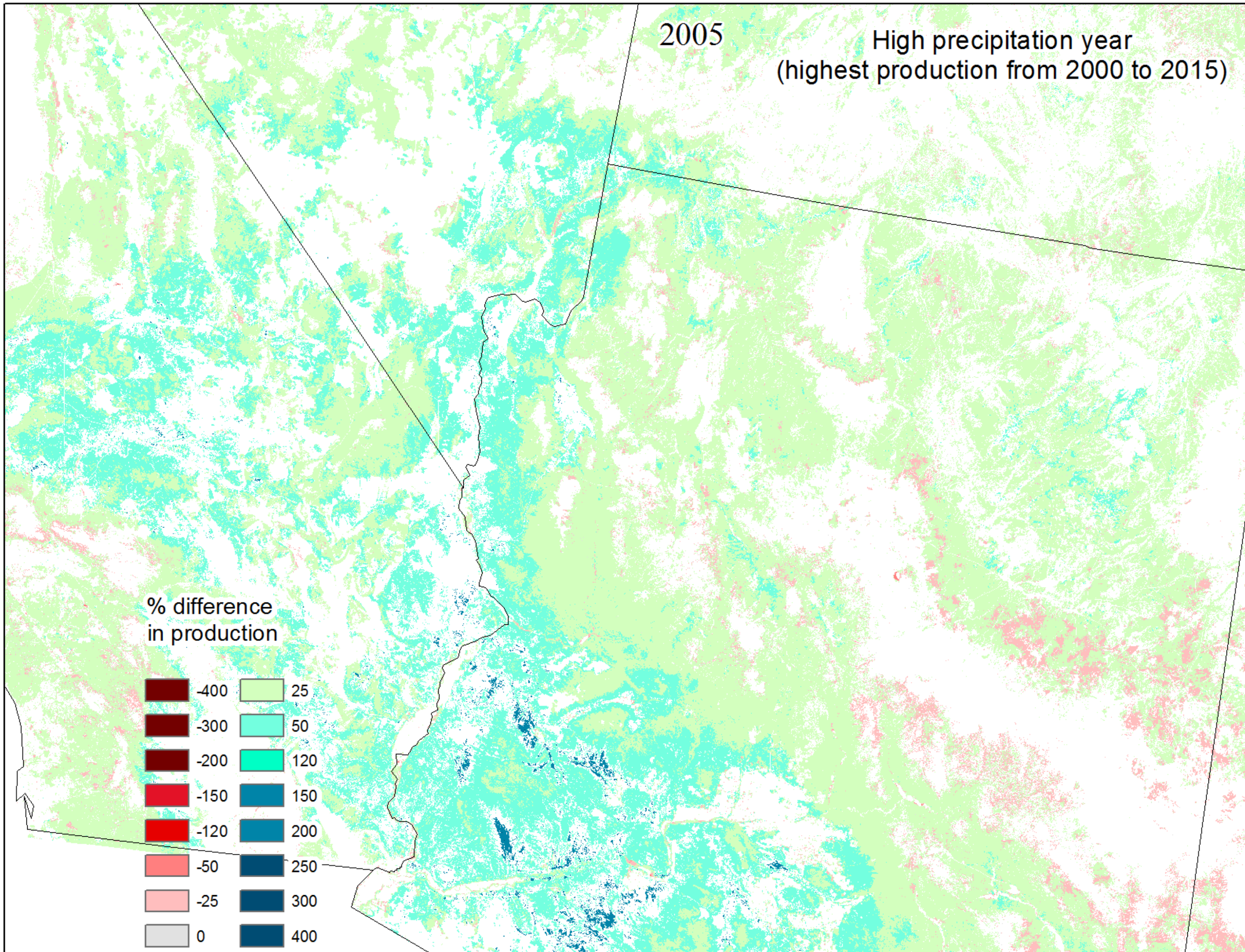




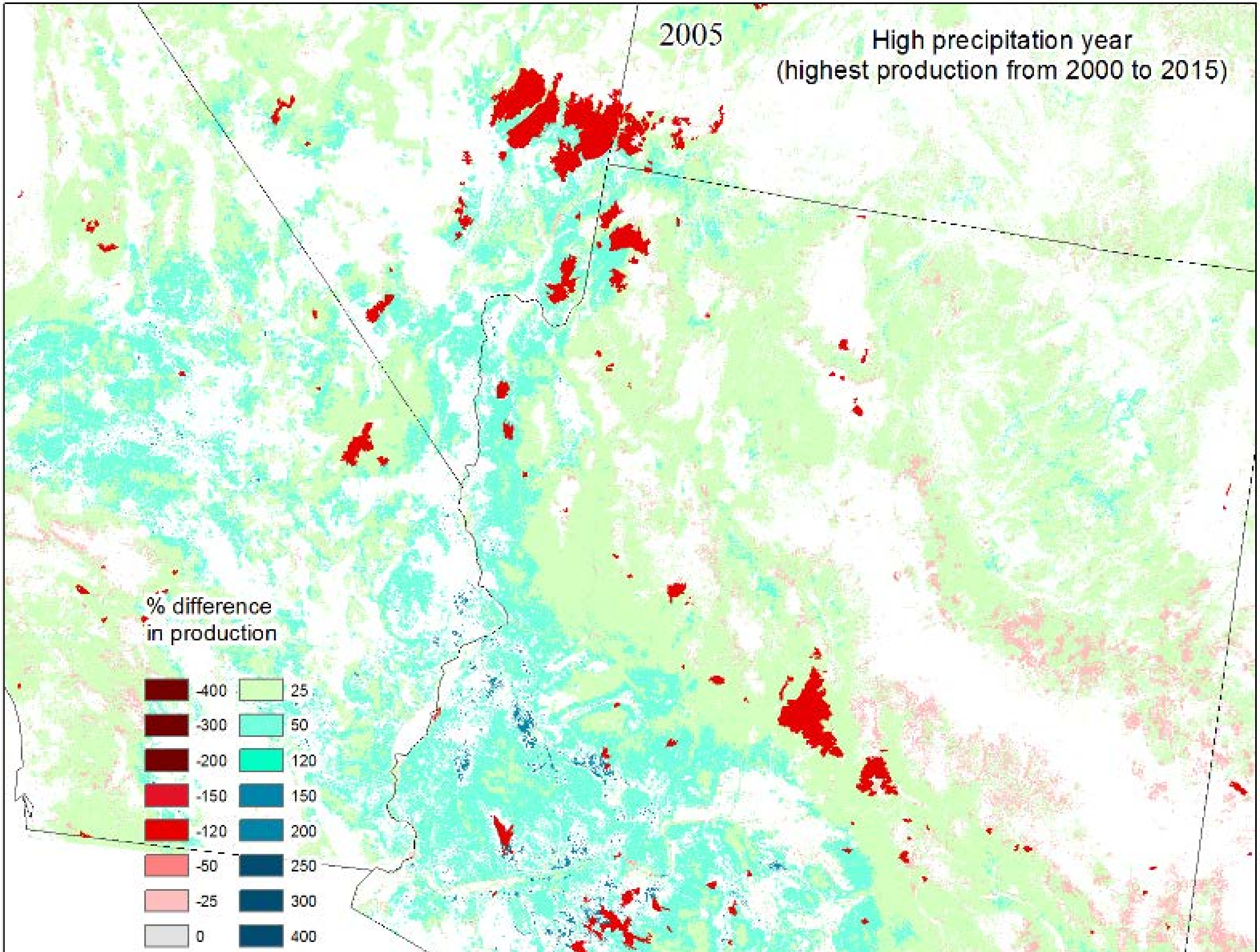
Linking fuels and annual production



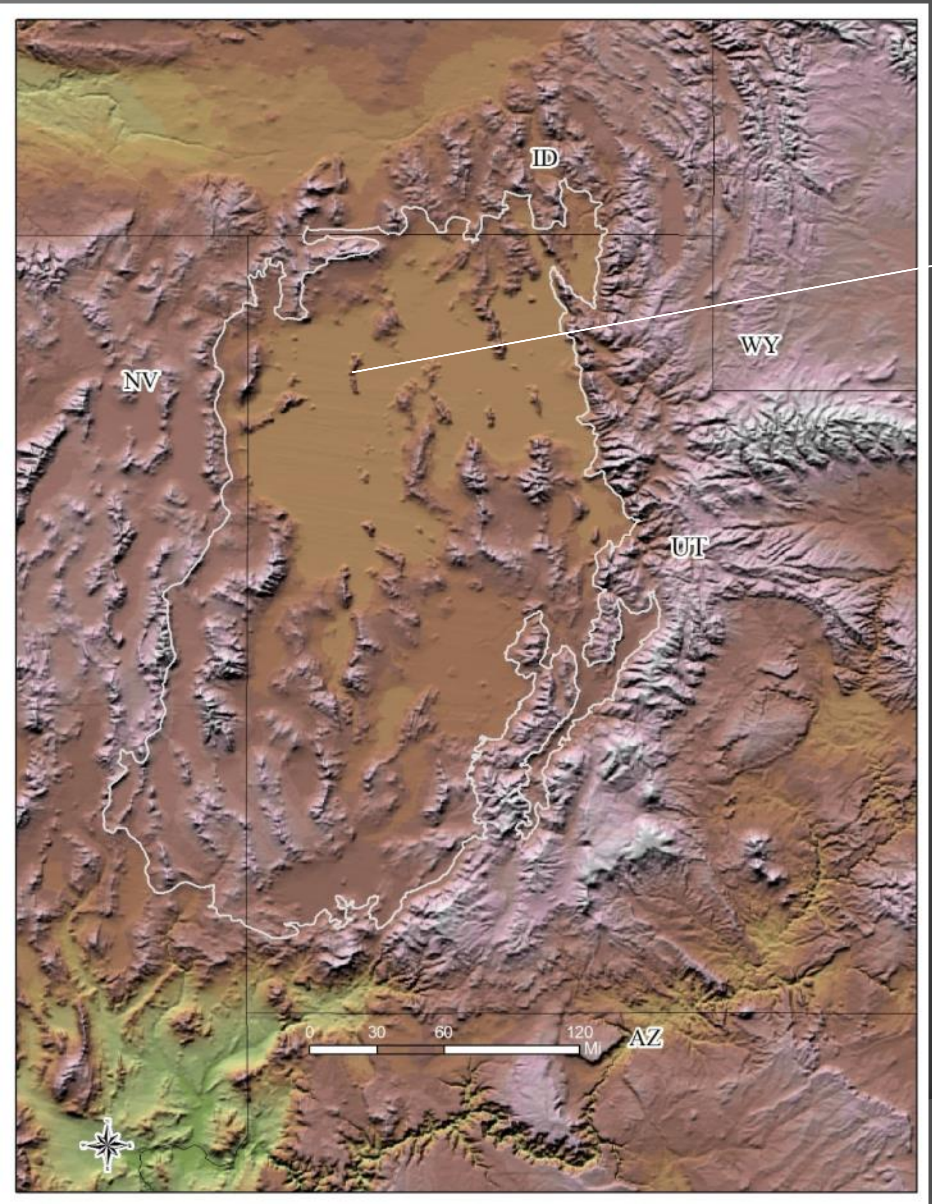
Linking fuels and annual production



Linking fuels and annual production

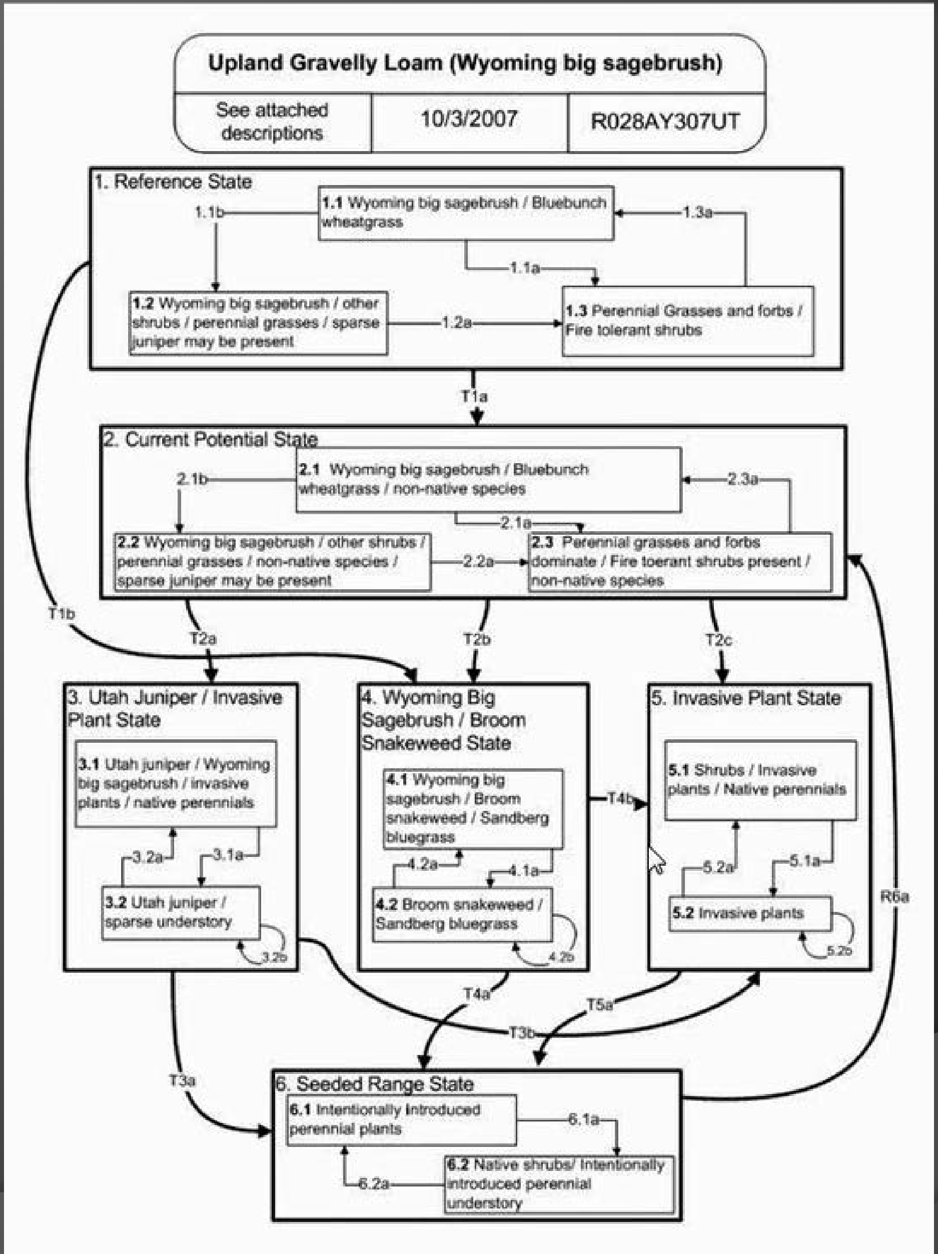


STSM: Upland Gravelly Loam Example

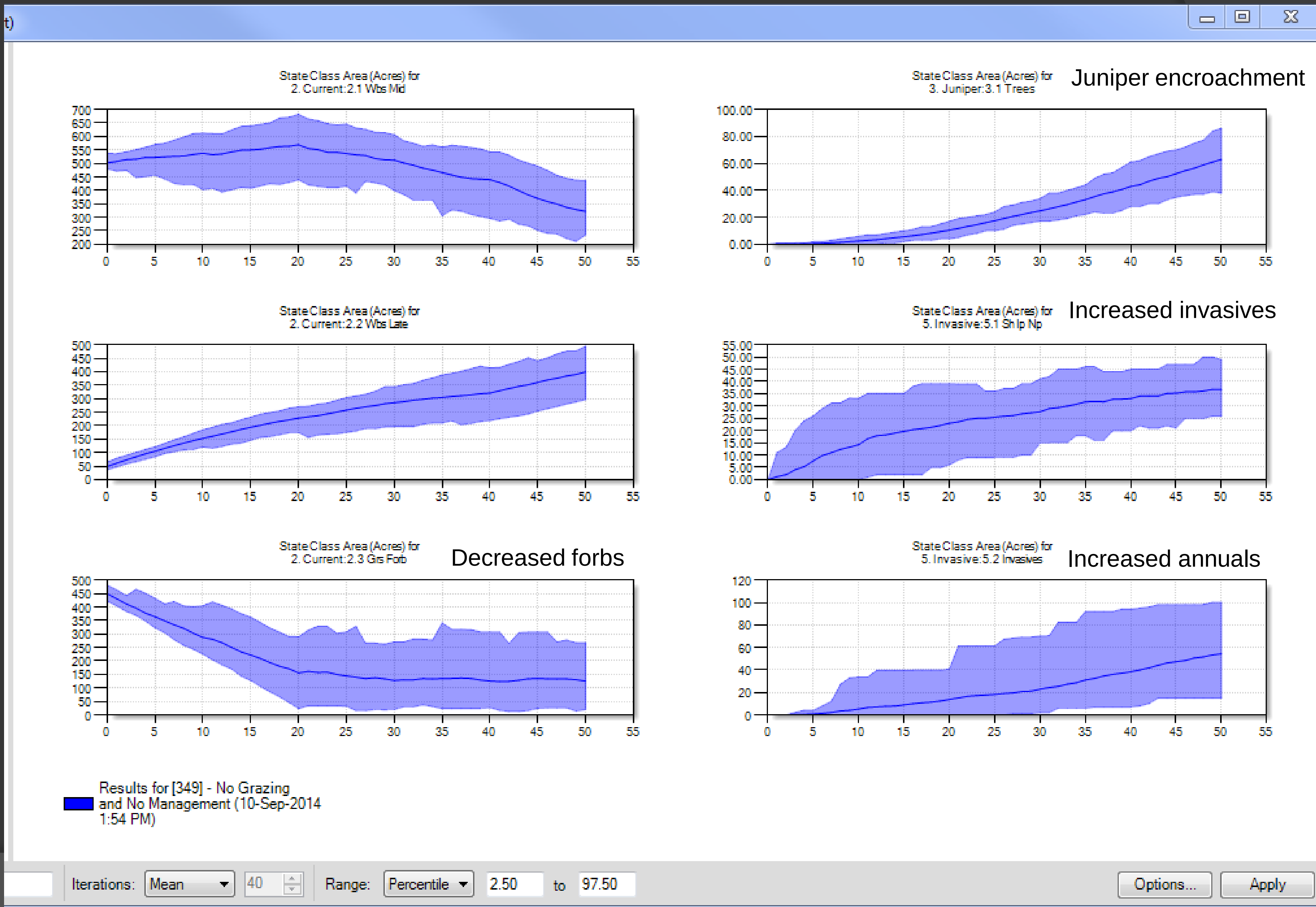


Upland Gravelly Loam
(Wyoming big sagebrush)
Ecological Site

STSM: Upland Gravelly Loam Example



Enables extension of time series: Connect present & future

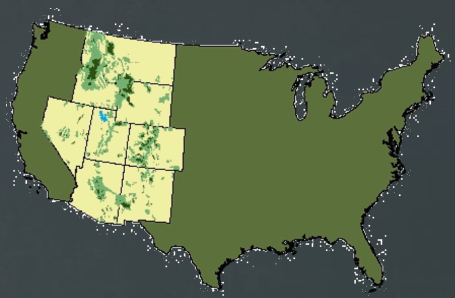


Broad-Scale Monitoring Strategy
Example of using FIA data

Paul L Patterson

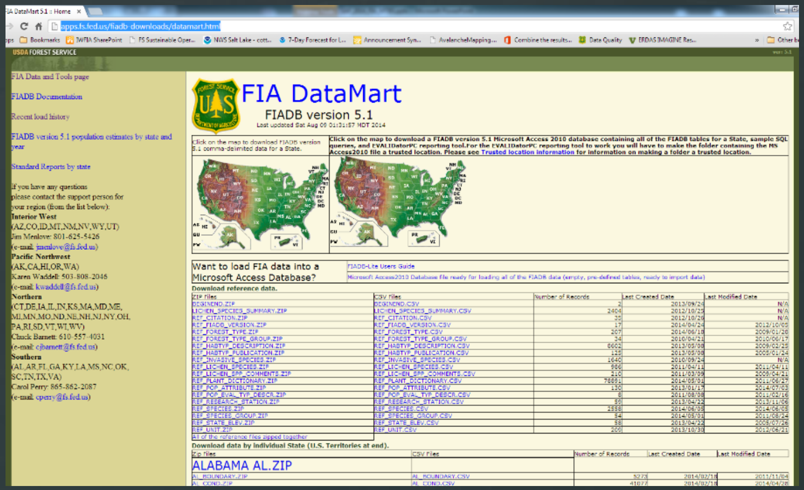
FIA
The Nation's Forest Census

Forest Inventory & Analysis (FIA) overview



The sample:

- Spatially balanced plot network (1 plot every 6k ac)
- Temporally balanced measurements (10-yr cycle)
- All forest types and ownerships
- *Available at: http://apps.fs.fed.us/fiadbdownloads/datamart.html*



Forest land = any area,
at least 120 feet wide and 1 acre in size,
with at least 10% tree canopy cover*

**currently or formerly,*
where land use has not changed

Stakeholders: Forest Service, Other US Government Agencies, State Foresters, Private Industry, Academia, Non-governmental Organizations, Private Citizens

FIA applications:

MTBS: Monitoring Trends in Burn Severity

- USFS/USGS collaboration
- Perimeter maps of all large fires, 1984-present
- “Large fires” are ≥ 1,000 acres (west) or 500 acres (east)
- Severity maps: low/unburned, low, moderate, and high severity

Available at:
MTBS.gov

Questions

- Area burned: how much is forest?
- Post-fire recovery: How do BA and regeneration change over time after fire?
- Fire severity: How does it relate to pre-fire basal area (BA)?
- Fire severity: How does it relate to forest type?
- Fire severity: Do the MTBS classes correspond to tree mortality levels?

Study area: 8 Interior West states

MTBS burned-area perimeters & FIA plots

6,170 fire perimeters (1984-2012)

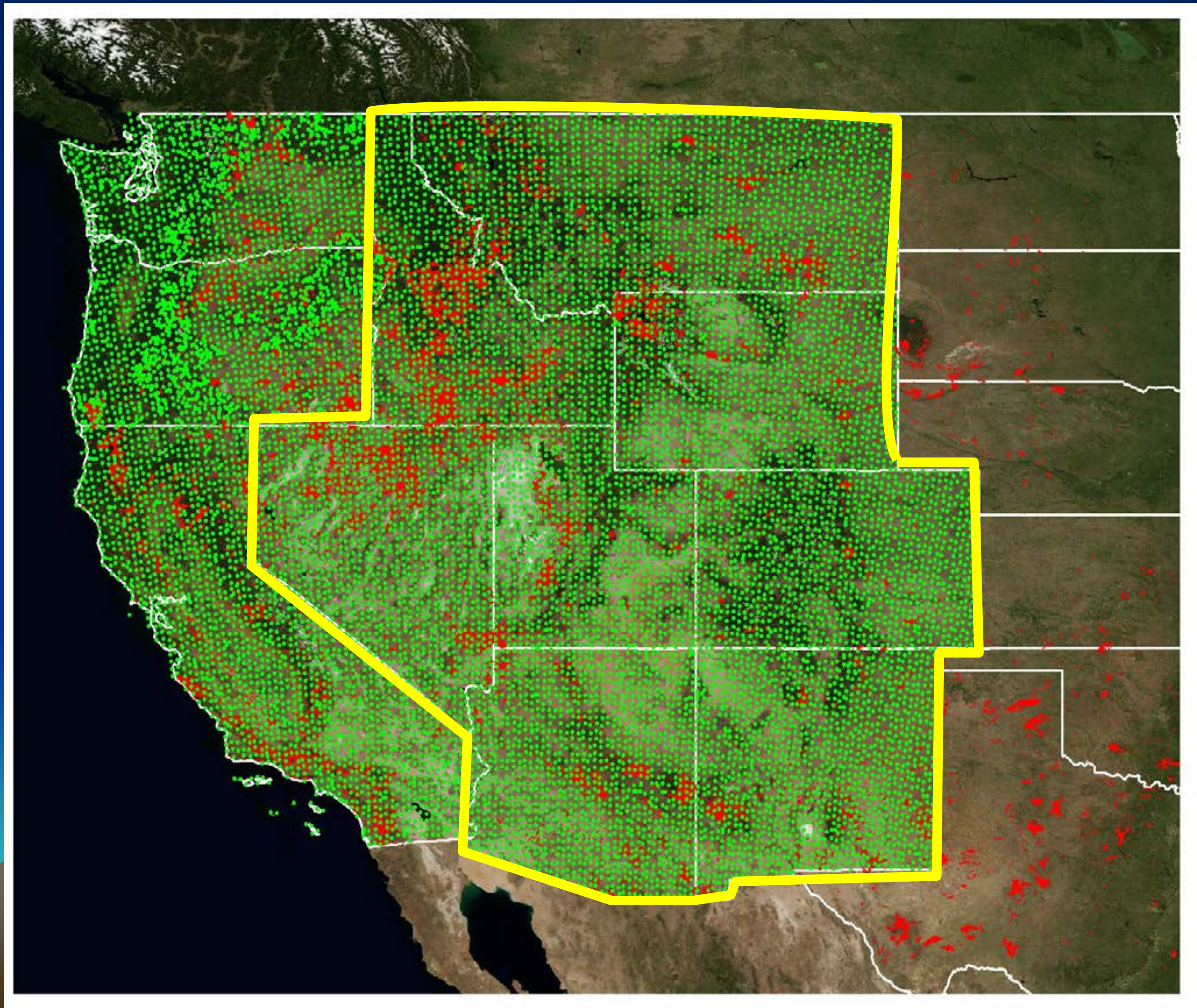
FIA plots:

6,372 total

3,219 forest

2,360 post-fire

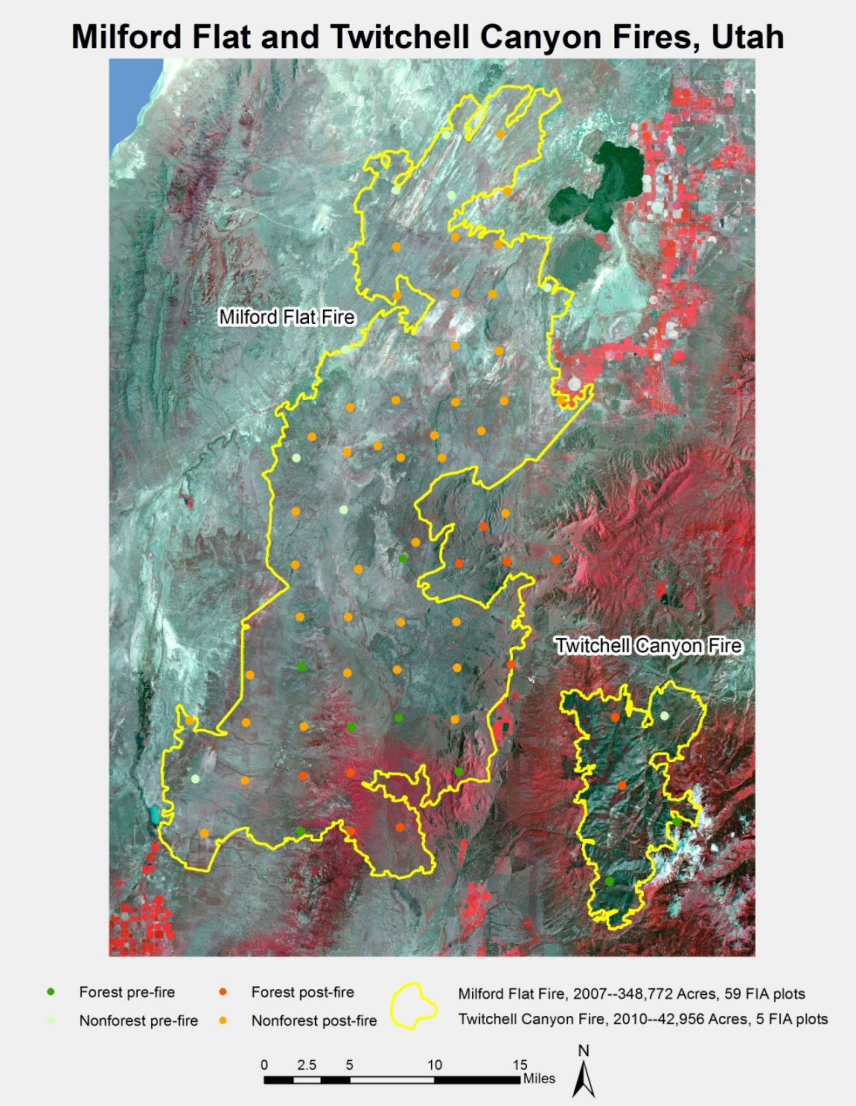
735 pre-fire *and* post-fire



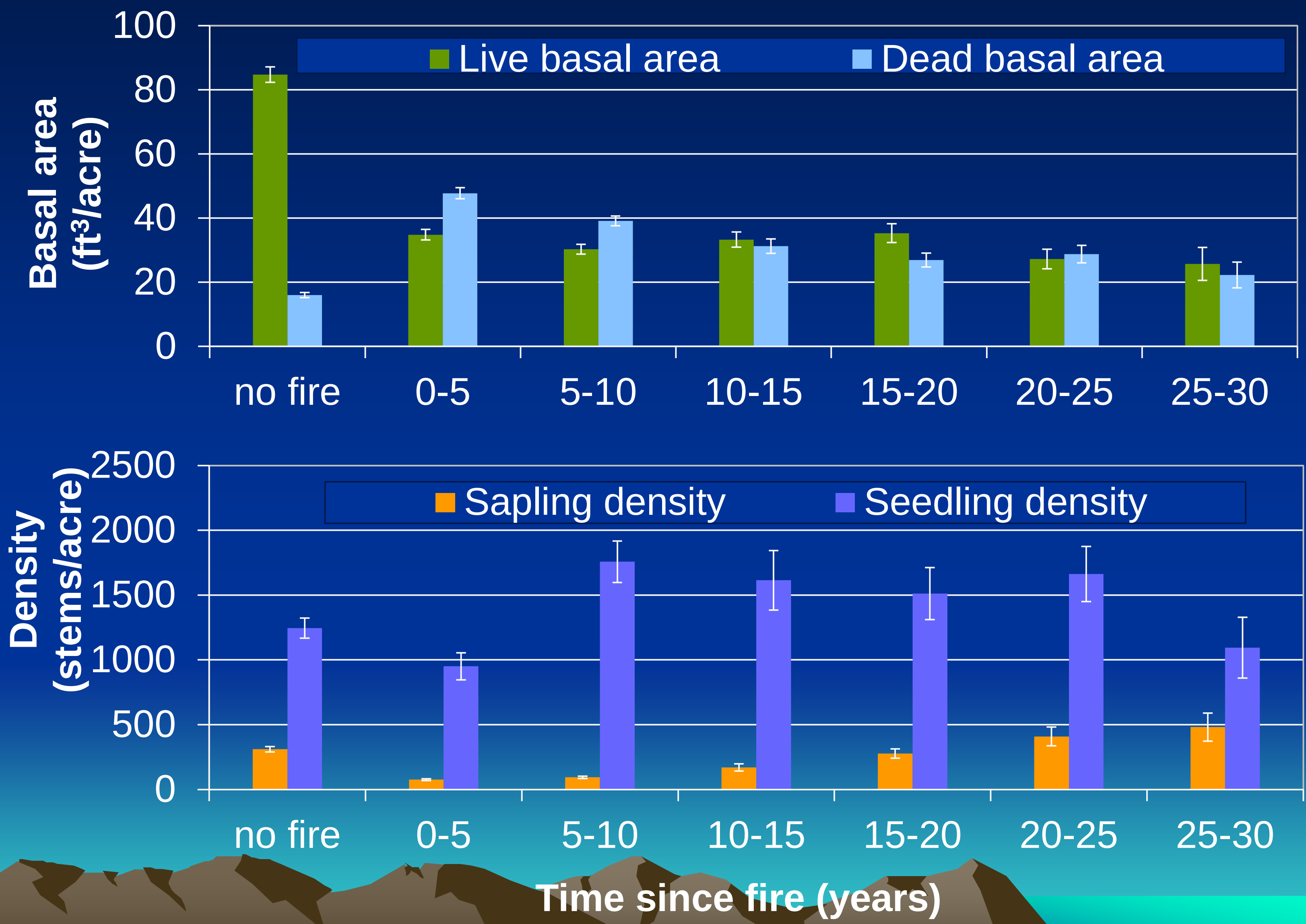
What burned: forest or nonforest?

Since 1984, large fires consisted of ~41% forest land and 59% nonforest.

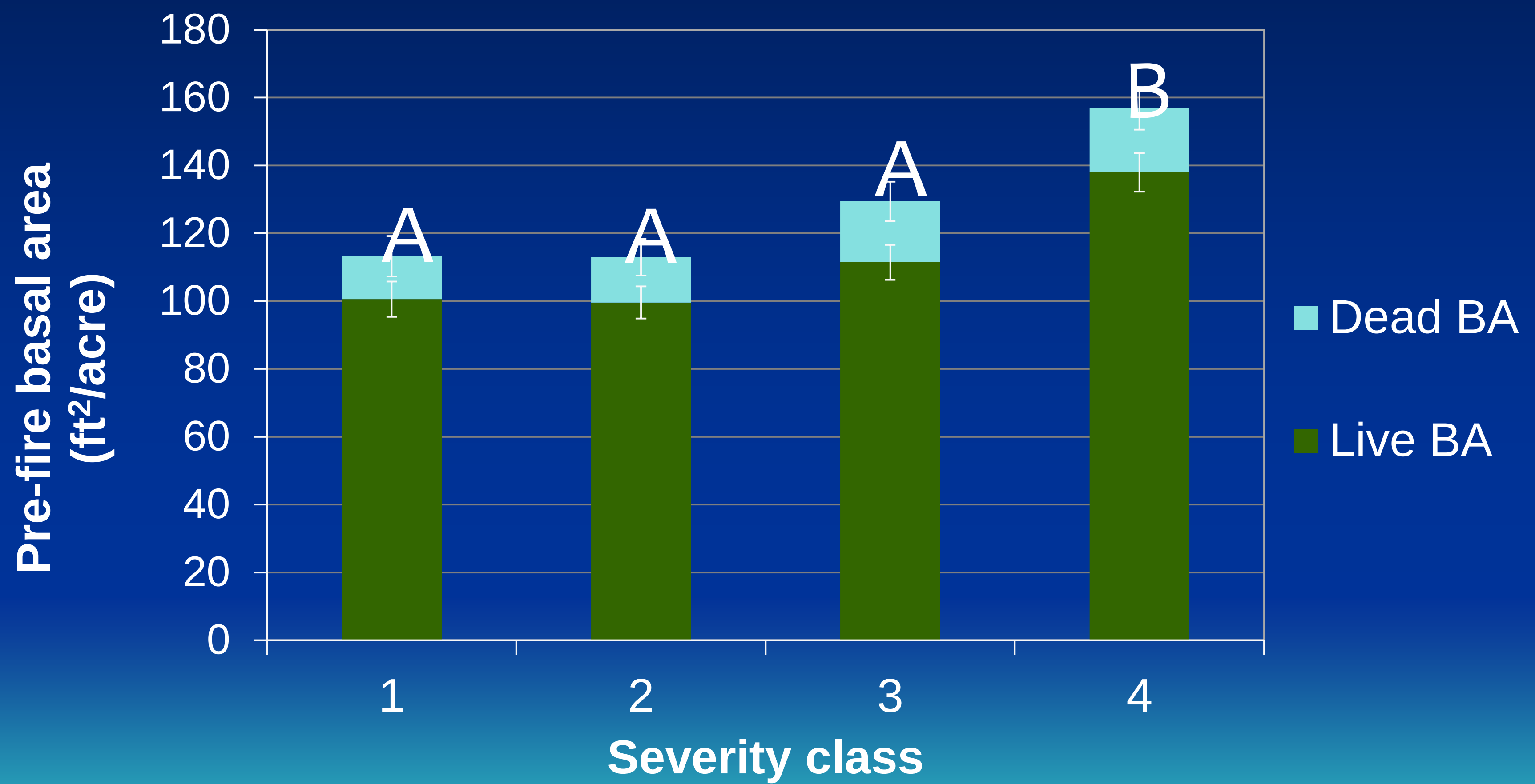
The % of burned-area that occurred in forests varied spatially, from 10% in Nevada to 65% in Montana.



Post-fire conditions – BA and regen density



Fire severity vs. pre-fire BA

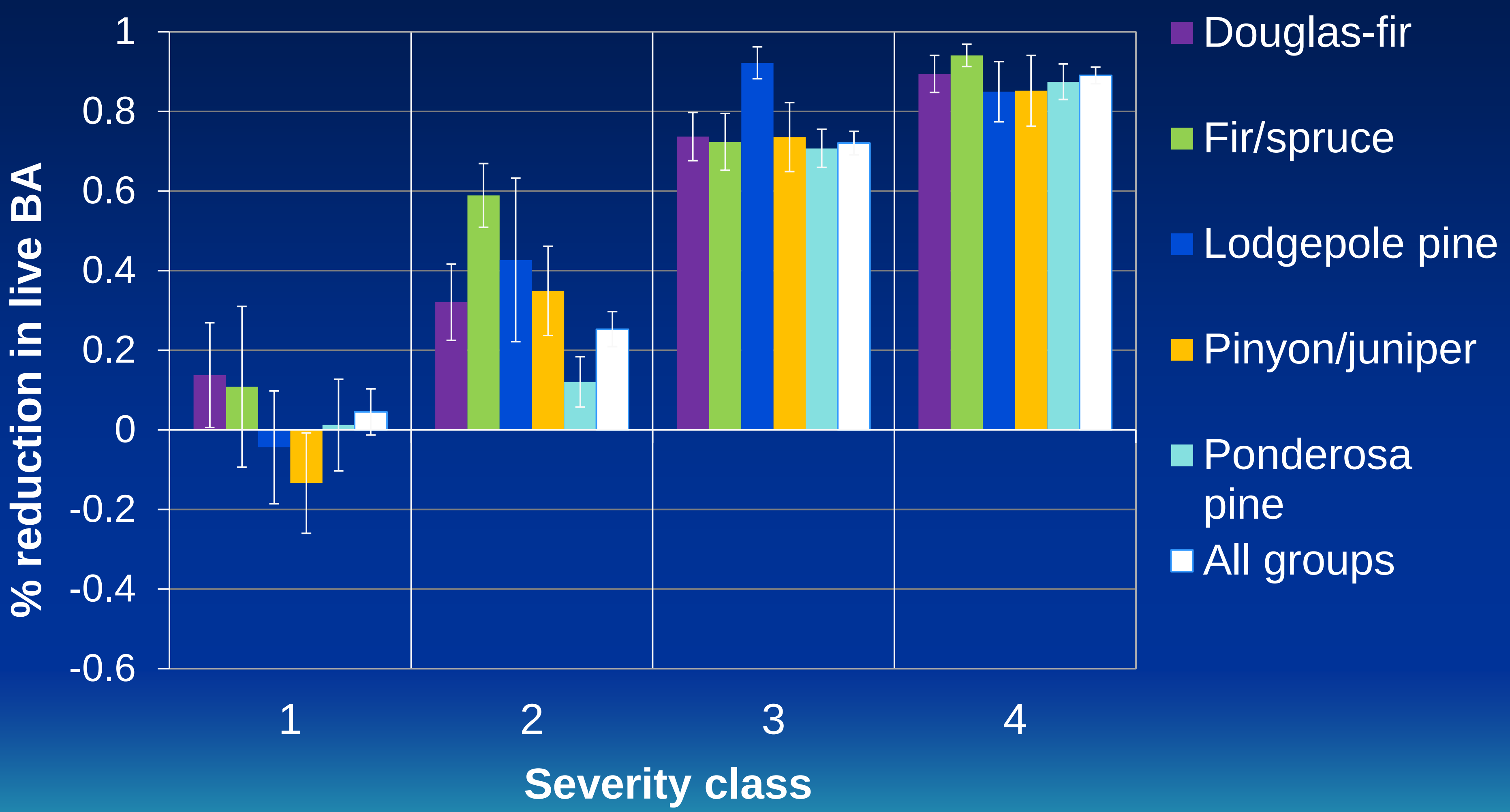


Fire severity by forest-type group

Forest-type group[1]	Number of remeasured plots in burned areas	Percentage of remeasured plots, by forest-type group, in each fire severity class			
		1	2	3	4
Aspen/birch	12	0%	25%	50%	25%
Douglas-fir	148	24%	24%	28%	24%
Fir/spruce/mountain hemlock	113	14%	20%	22%	43%
Lodgepole pine	57	32%	23%	14%	32%
Other western softwoods	20	20%	35%	25%	20%
Pinyon/juniper	145	26%	37%	25%	12%
Ponderosa pine	172	23%	38%	25%	14%
Western larch	5	20%	20%	40%	20%
Woodland hardwoods	63	24%	37%	30%	10%
All groups	**735**	**23%**	**31%**	**25%**	**22%**

[1] *Not shown: forest-type groups that occur in IW states but did not occur at T1 at remeasured plots.*

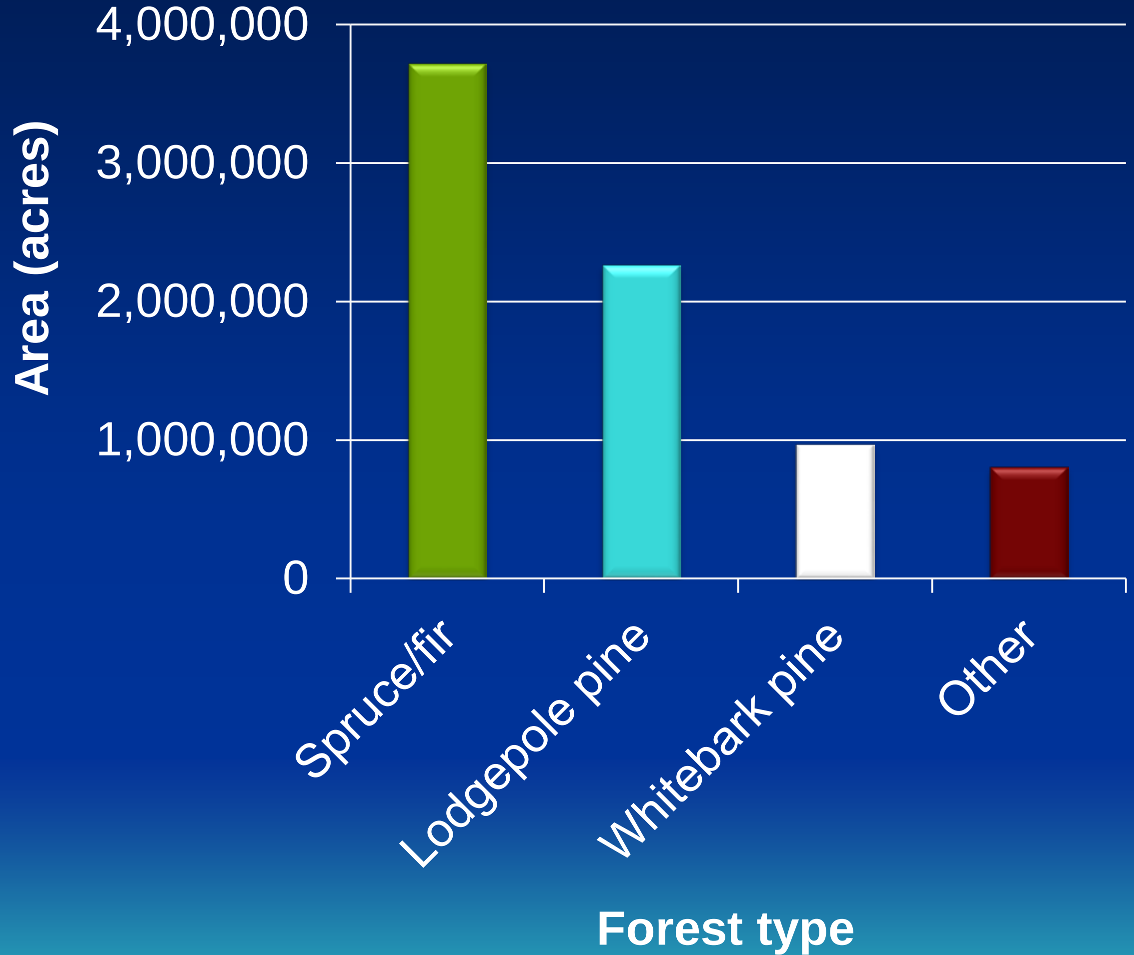
Fire severity classes and % BA reduction



FIA applications

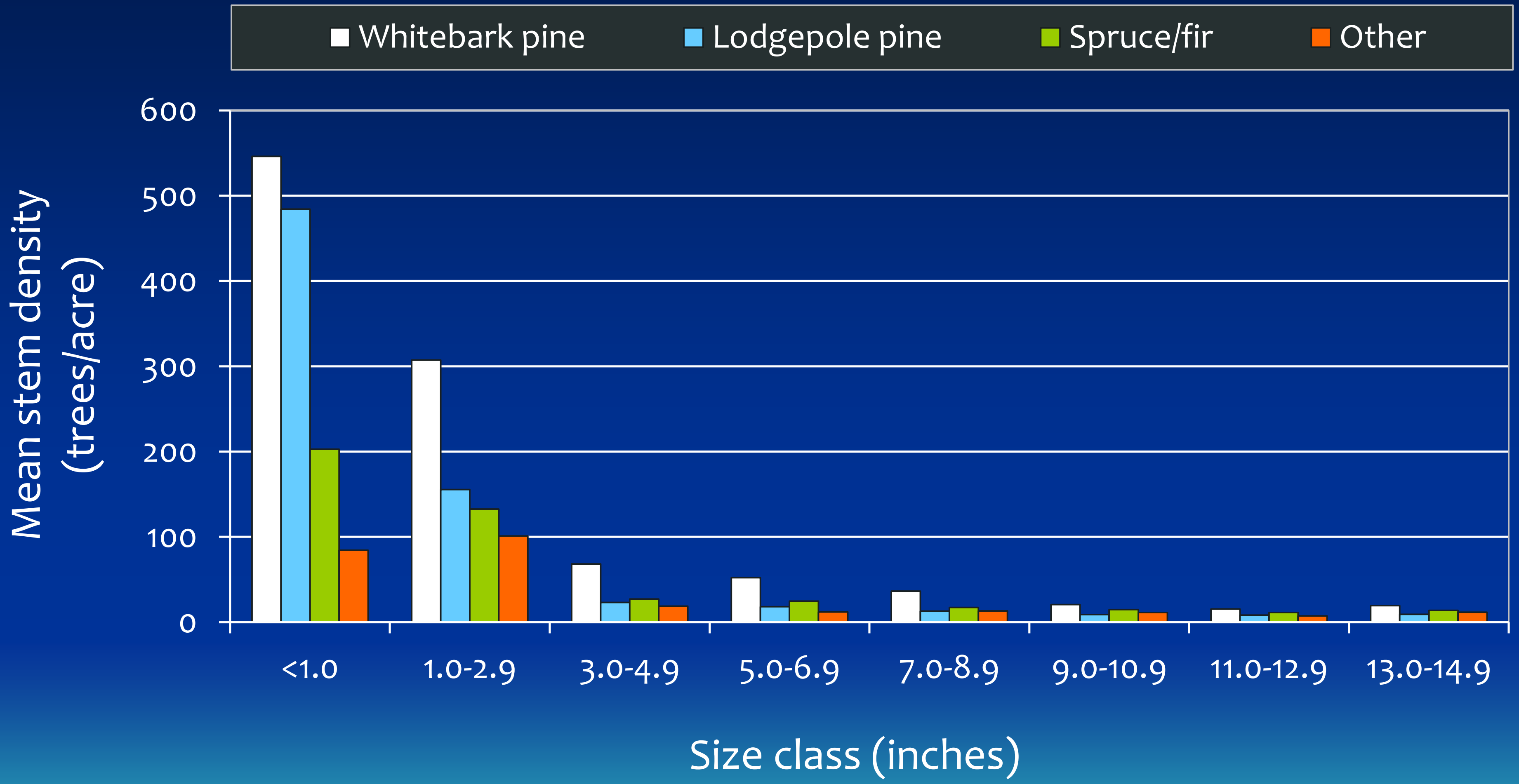
Species of interest:
whitebark pine assessment

Area of forest land with a WBP component

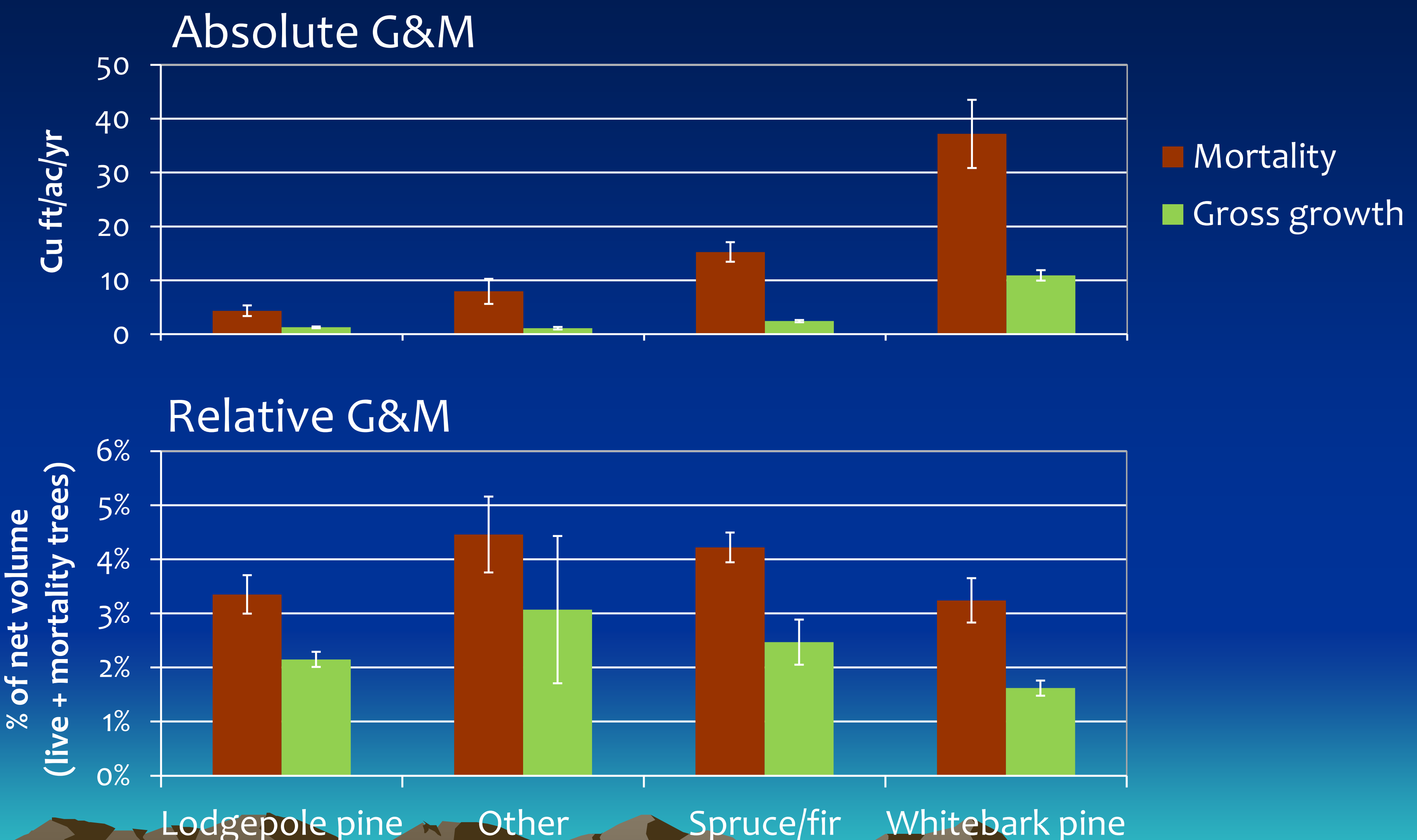


WBP sapling in lodgepole pine stand, Salmon River Mountains, Idaho

Size class distribution



Mean mortality and growth, by forest type



FIA applications:

Wildlife habitat assessment and monitoring

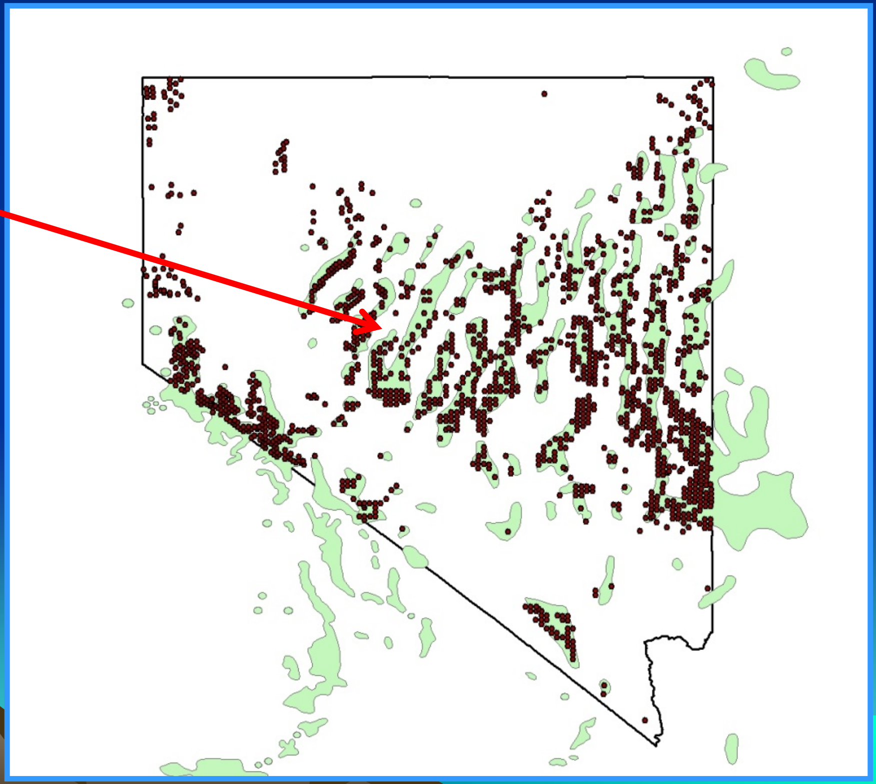
Off-grid plot measurements

- Establish a full or partial plot inventory off the standard FIA grid at a site based on importance/use by the species of interest.

- Data can be related back to standard FIA data to identify all plots that meet habitat criteria and thus provide area estimates of preferred habitat in a geographic area of interest.

Examples: Pinyon jays of the Great Basin, Lewis's woodpecker, Mexican spotted owls of the Southwest U.S.

Pinyon jay use of pinyon-juniper

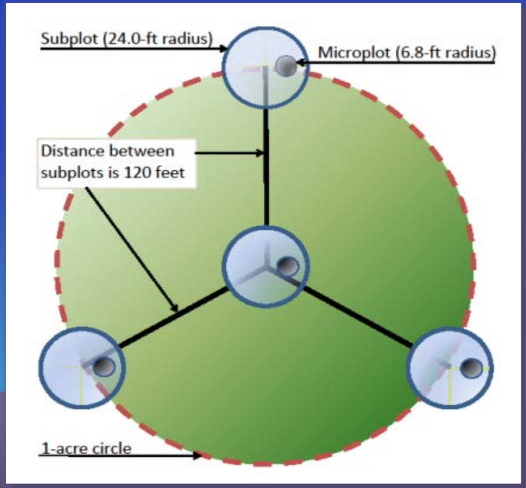


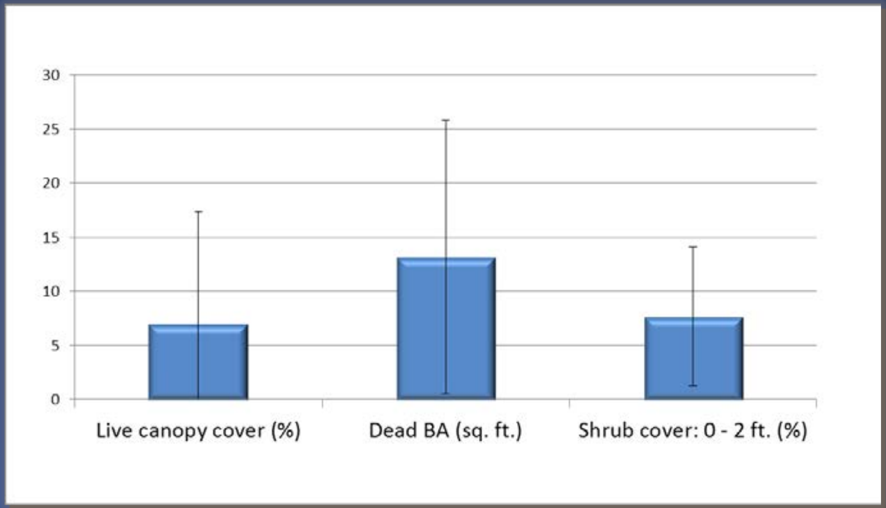
Methods: data collection

GBBO and NPS staff locate and observe birds mark cache sites

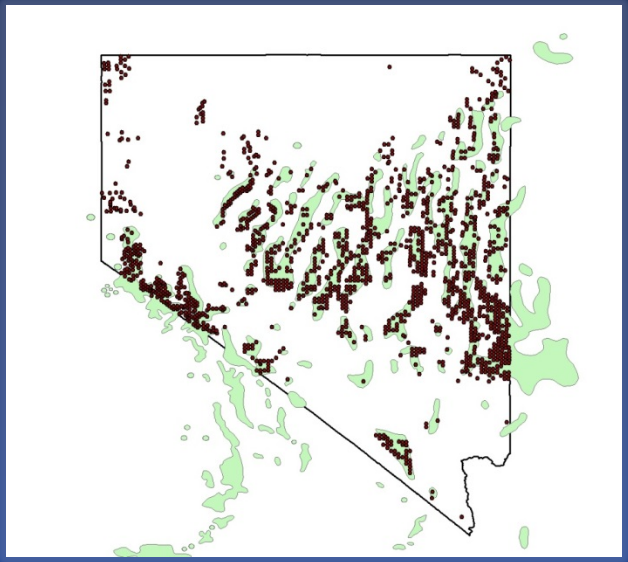
Capture birds and attach radio transmitters (n = 8)

FIA crews establish plot at cache site

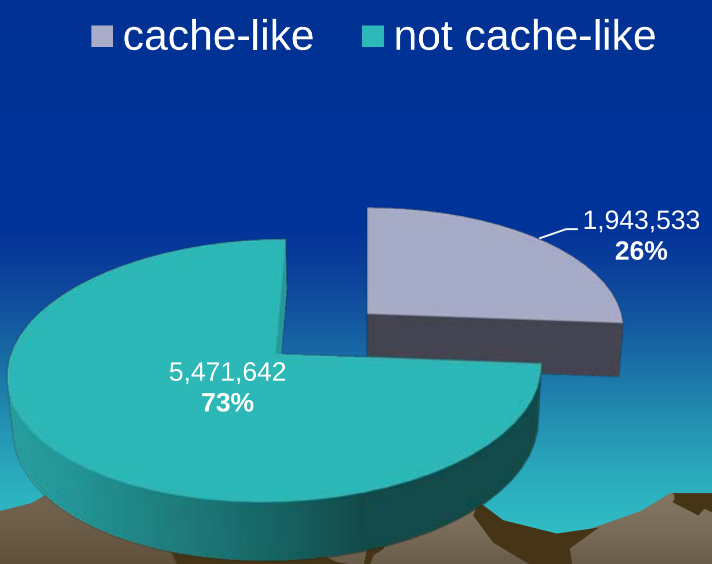




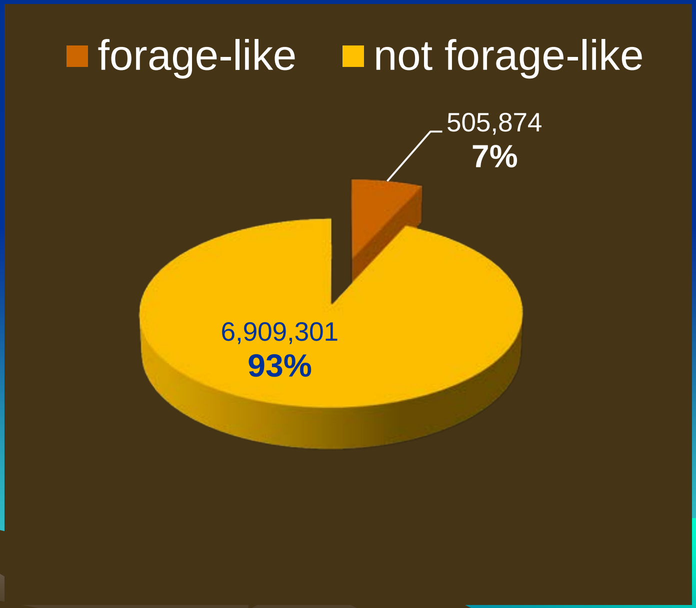
Canopy cover, dead BA, shrub cover +/- 1 SD



1200+ plots = 7.4 million acres



Foraging Sites



Thank you

Integrated Monitoring in Bird Conservation Regions

David Pavlacky

Bird Conservancy of the Rockies

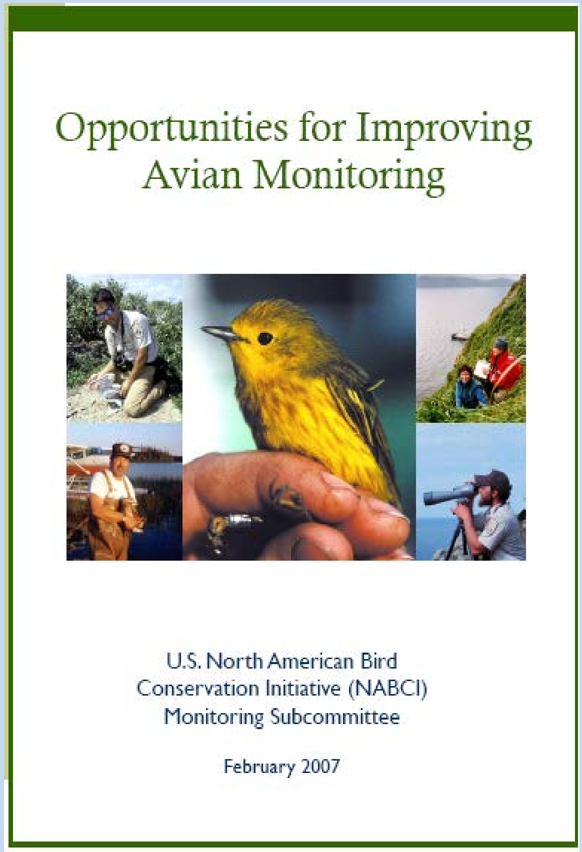
Contact Info
david.pavlacky@birdconservancy.org

Challenges for large scale monitoring

- Conservation objectives not clearly articulated
  - Data not linked to available management actions
- Lack of coordination across regions and organizations
  - Historically restricted to local scales
  - Disparate sampling designs and protocols
- Limited application of best available science
  - Haphazard sampling designs
    - Convenience sampling
  - Failure to account for incomplete detection
    - Reliance on indices

Opportunities for improving avian monitoring

1. Integrate monitoring into management and conservation
2. Coordinate monitoring programs among organizations and spatial scales
3. Increase the value of monitoring data by improving statistical design
4. Maintain monitoring data in modern data management systems



US NABCI Monitoring Subcommittee, 2007, USFWS.

NABCI monitoring objectives

1. Determine status and trends of populations

US NABCI Monitoring Subcommittee, 2007, USFWS.

NABCI monitoring objectives

1. Determine status and trends of populations
2. Inform management and policy to achieve conservation
3. Evaluate conservation efforts
4. Inform conservation design
5. Set population objectives and management priorities

US NABCI Monitoring Subcommittee, 2007, USFWS.

NABCI monitoring objectives

1. Determine status and trends of populations
2. Inform management and policy to achieve conservation
3. Evaluate conservation efforts
4. Inform conservation design
5. Set population objectives and management priorities
6. Determine causes of population change

US NABCI Monitoring Subcommittee, 2007, USFWS.

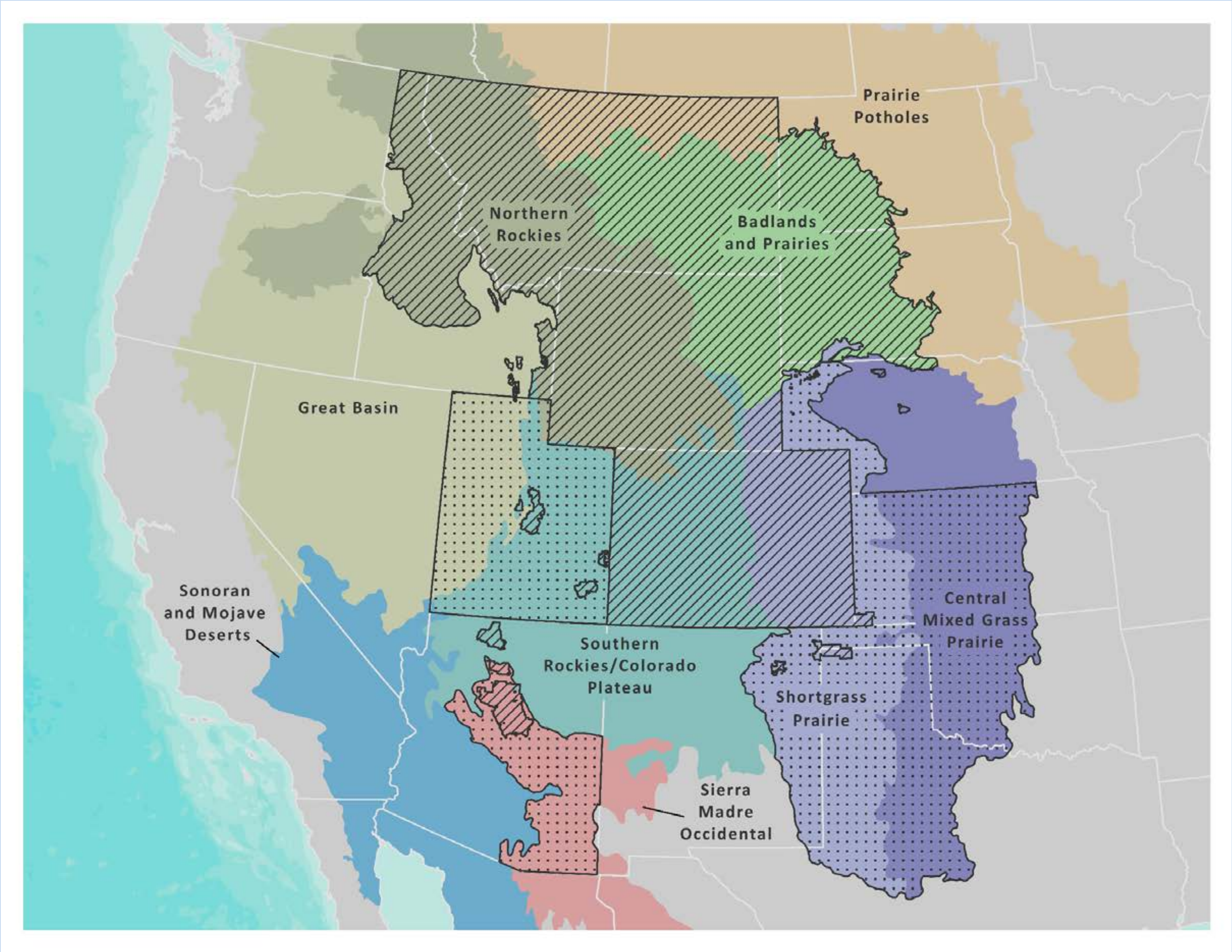
Black-capped vireo

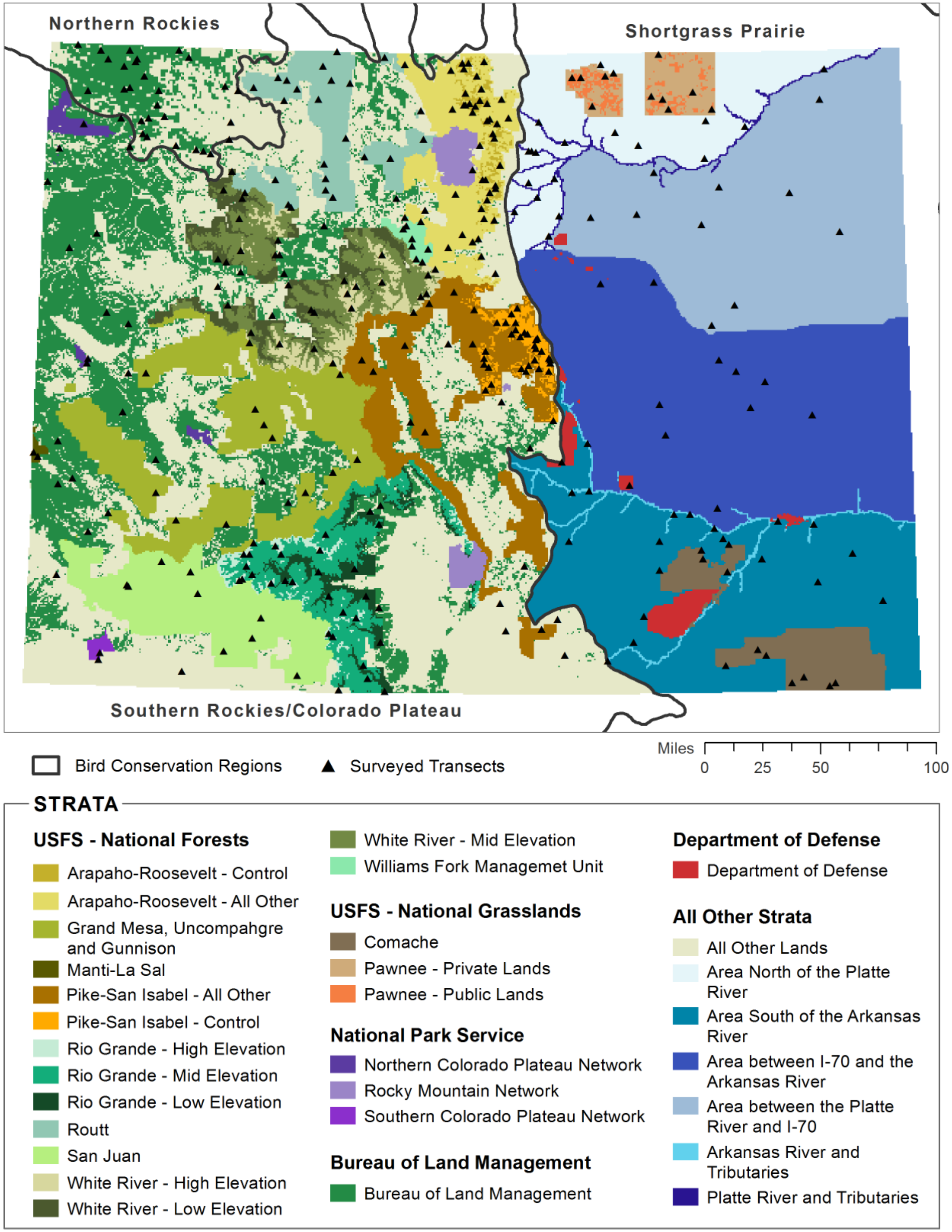
Dennis Cooke

Key elements: IMBCR sampling design

- Hierarchical stratification scheme
    - Stratified management units at local scales
    - Nested management units aggregated at multiple scales
- Spatially balanced (probabilistic) sampling
    - Allows valid inference to large regions
    - Accommodates fluctuations in funding and sampling intensity
- Estimation of detection probabilities
    - Ensures observed patterns are not artifacts of the observation process
    - Pooling detections improves precision of population estimates

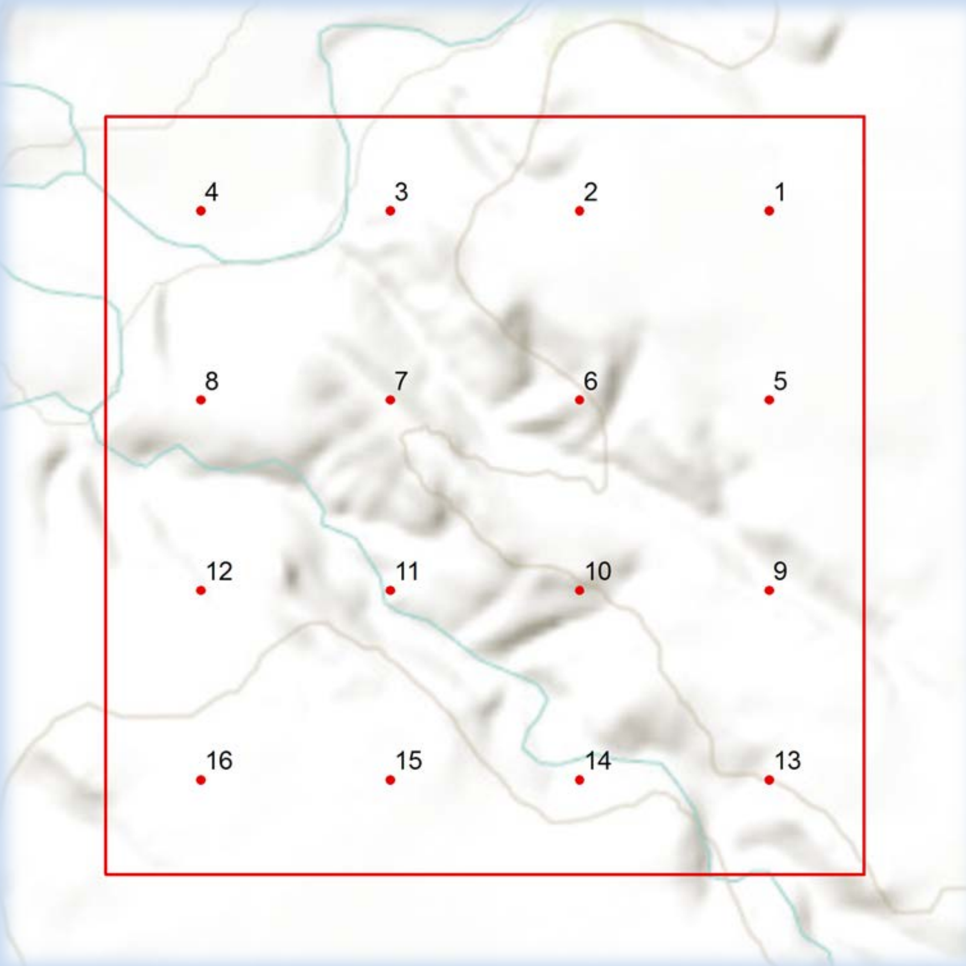
2016 area of inference: ~2 M km^2





Northern Rockies
Shortgrass Prairie
Southern Rockies/Colorado Plateau
Bird Conservation Regions
Surveyed Transects
Miles
0
25
50
100
STRATA
USFS - National Forests
Arapaho-Roosevelt - Control
Arapaho-Roosevelt - All Other
Grand Mesa, Uncompahgre and Gunnison
Manti-La Sal
Pike-San Isabel - All Other
Pike-San Isabel - Control
Rio Grande - High Elevation
Rio Grande - Mid Elevation
Rio Grande - Low Elevation
Routt
San Juan
White River - High Elevation
White River - Low Elevation
White River - Mid Elevation
Williams Fork Managemet Unit
USFS - National Grasslands
Comache
Pawnee - Private Lands
Pawnee - Public Lands
National Park Service
Northern Colorado Plateau Network
Rocky Mountain Network
Southern Colorado Plateau Network
Bureau of Land Management
Bureau of Land Management
Department of Defense
Department of Defense
All Other Strata
All Other Lands
Area North of the Platte River
Area South of the Arkansas River
Area between I-70 and the Arkansas River
Area between the Platte River and I-70
Arkansas River and Tributaries
Platte River and Tributaries

Sampling unit: 1-km^2 grid cell

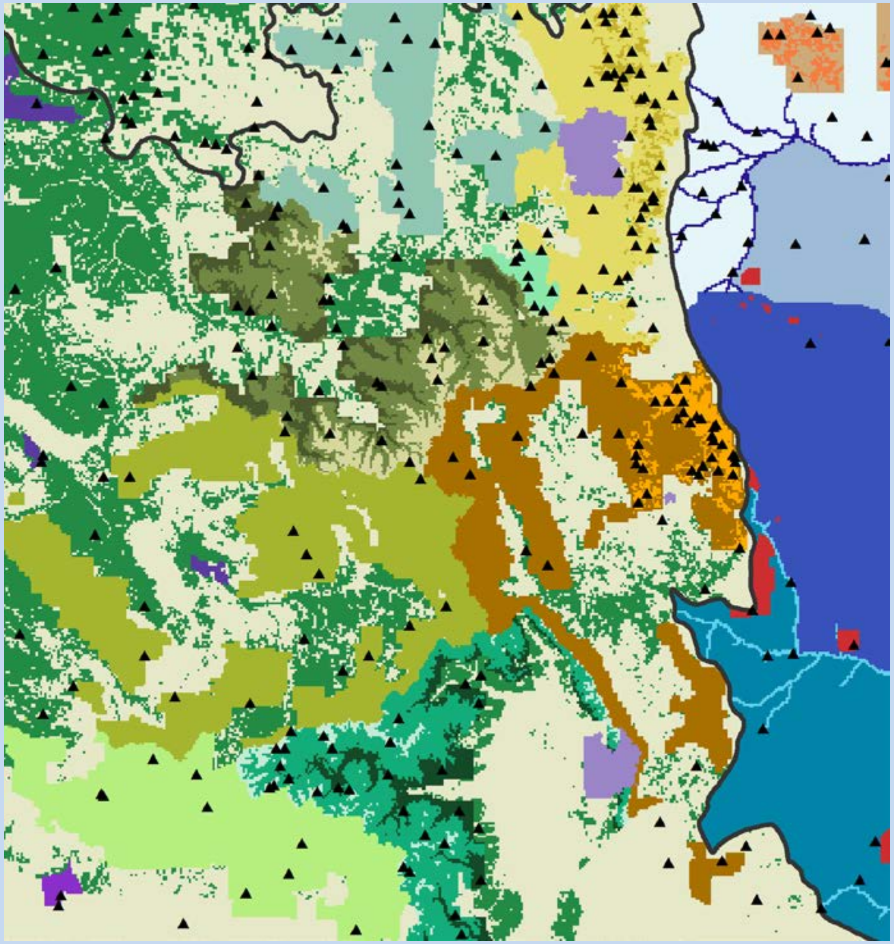


Bird Conservancy of the Rockies

Sample selection and allocation

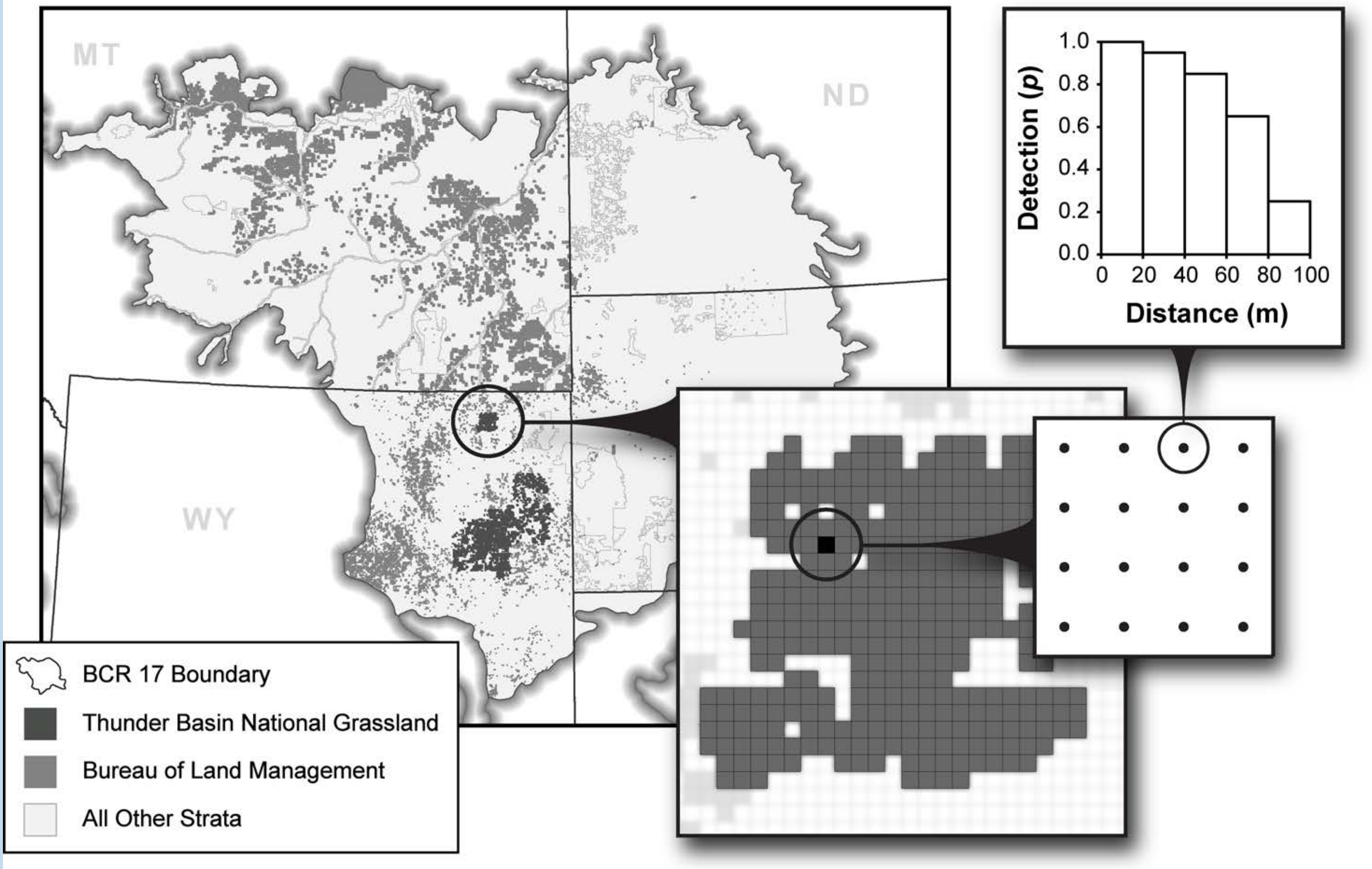
Generalized Random Tessellation Stratification (GRTS)

- Spatially-balanced property is maintained when:
  - Sample sizes fluctuate between years
  - Topography or safety concerns prevent access
  - Private landowners deny permission

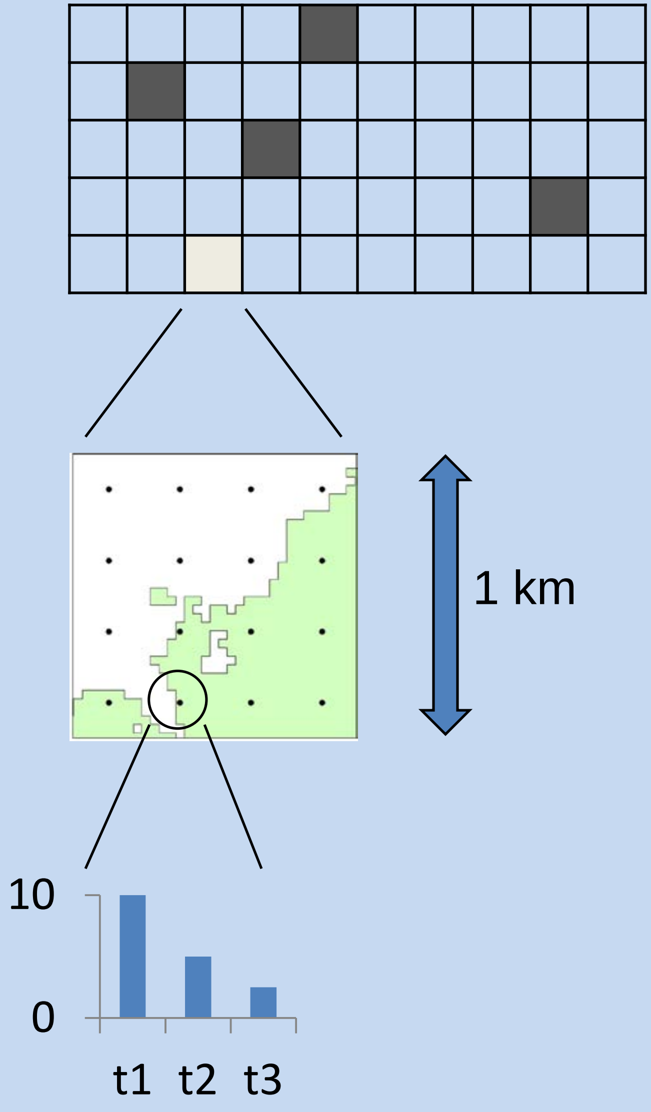


Bird Conservancy of the Rockies

Hierarchical sampling design



Multi-scale occupancy



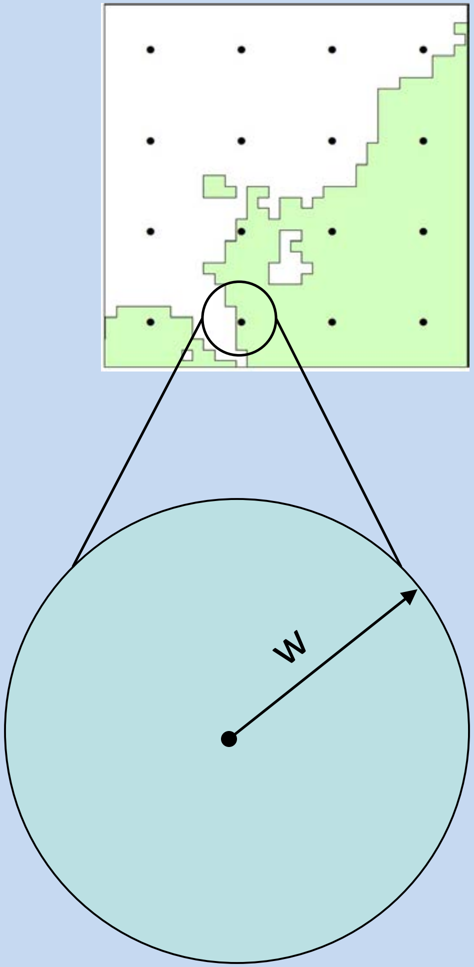
Large-scale occupancy of grid cells (ψ)

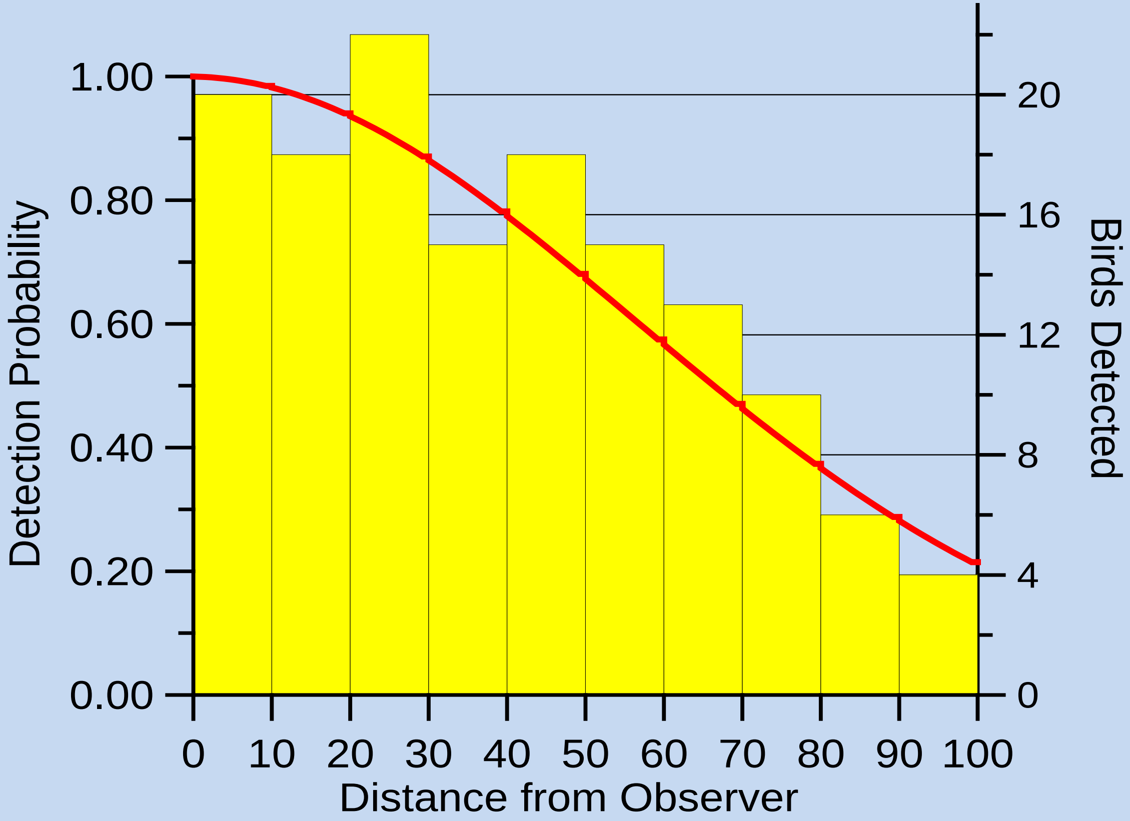
Small-scale occupancy of points (θ)

Detection in minute intervals (*p*)

Pavlacky et al., 2012, J. Wildl. Manag., Vol. 76.

Point-transect distance sampling: density and population size

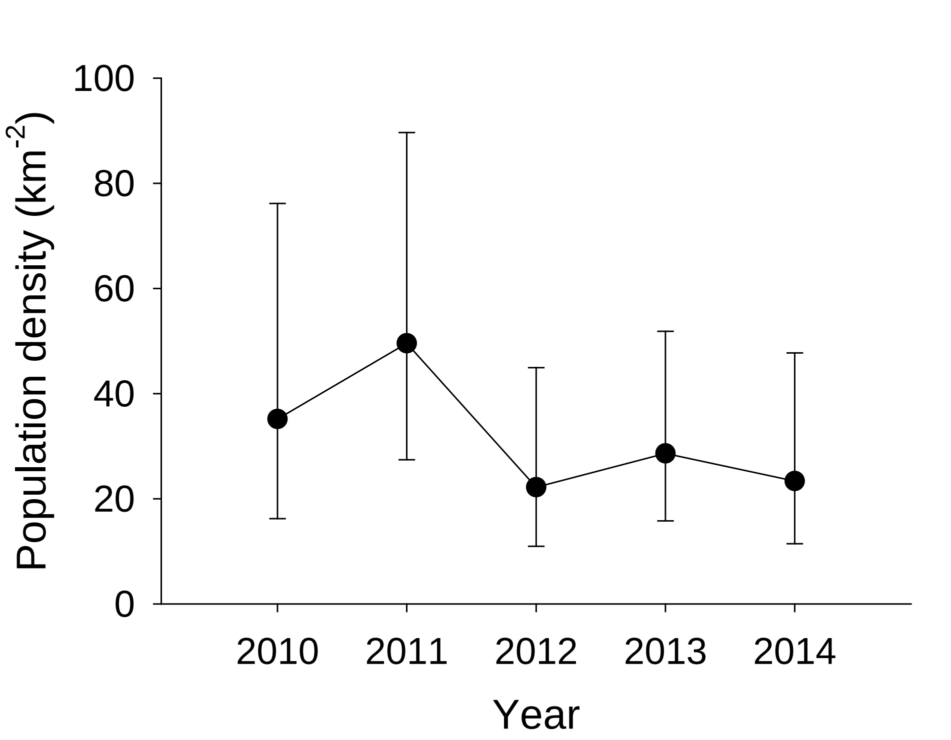




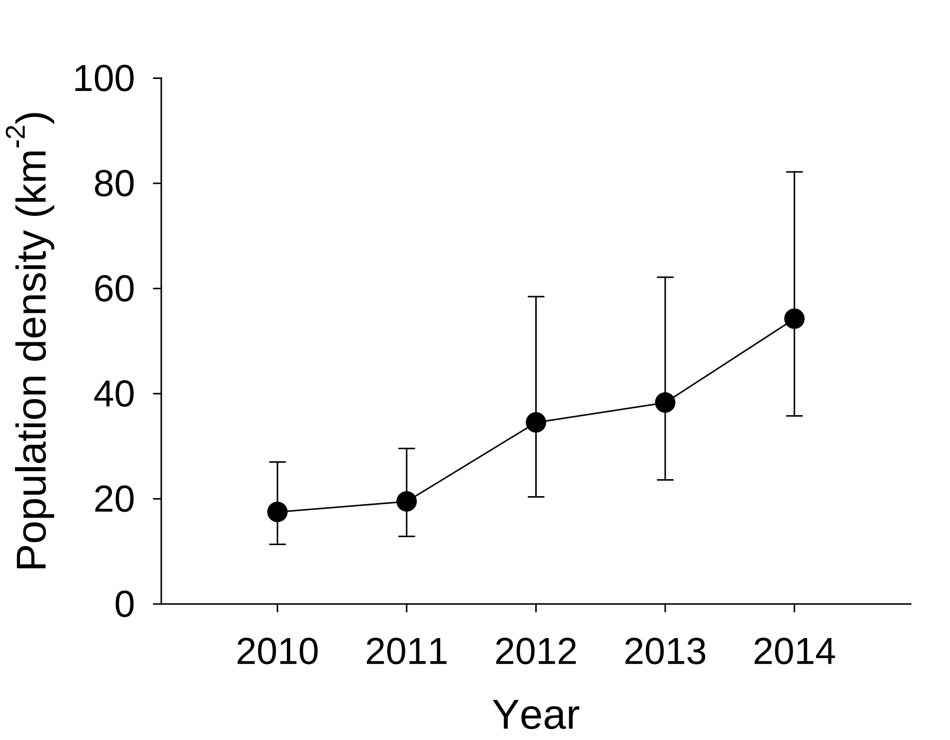
Thomas et al., 2010, J. Appl. Ecol., Vol. 47.

Population density of Brewer's sparrow at multiple scales

Thunder Basin National Grassland



BLM lands within BCR 17



Conclusions

1. **Ensure relevance to resource management**
   - Integrate monitoring data into conservation objectives
2. **Increase sampling efficiency and cost effectiveness**
   - Coordinated monitoring and analysis
3. **Provide reliable knowledge about bird populations at multiple spatial and temporal scales**
4. **Increase the credibility of monitoring data**
   - Scientific method of posing and answering questions
5. **Provide confidence to policymakers and funders**
   - Increase accountability in the use of public funds

Bird Conservancy of the Rockies

IMBCR Funding Partners

The Role of Remote Sensing in Broader-scale Environmental Monitoring:

USFS RSAC Overview and Example Applications

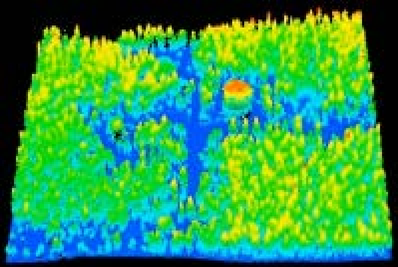
Mark Finco, PhD
Senior Scientist
RedCastle Resources, Inc.

Kevin Megown
Program Leader

USDA Forest Service
Remote Sensing Applications Center (RSAC)
Salt Lake City, Utah

Talk Overview

- USFS Remote Sensing Applications Center
  - Mission, Organization, Capacity, Services
- Example Monitoring Applications
  - Monitoring Trends in Burn Severity (MTBS)
  - FHP Forest Disturbance Monitor (FDM)
  - Image-based Change Estimation (ICE)



USDA

Forest Service Chief

- International Programs

Deputy Chief State & Private

- Fire & Aviation
- Forest Health
- Cooperative Forestry
- Community Ed
- Urban and Community Forestry
- Tribal Relations

Deputy Chief Nat'l Forest System

- Regional Offices & National Forests
- Ecosystem Management Coordination
- Forest Management
- Lands
- Minerals & Geology
- Range Management
- Rec & Heritage
- Watershed, Fish, Wildlife, Air, and Rare Plants
- **Engineering, Technology, and Geospatial Services**

Deputy Chief Research

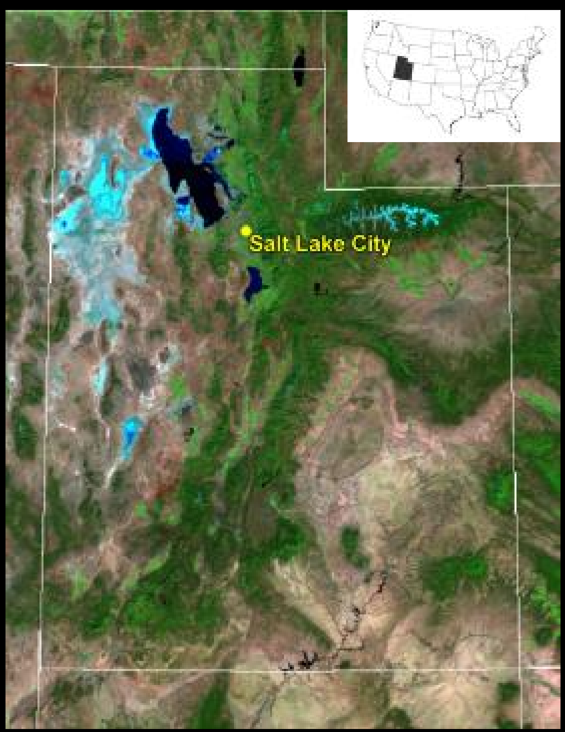
- Landscape Restoration & Ecosystem Services
- Sustainable Forest Mgmt
- Policy Analysis
- Inventory, Monitoring & Assessment

Deputy Chief Business Ops

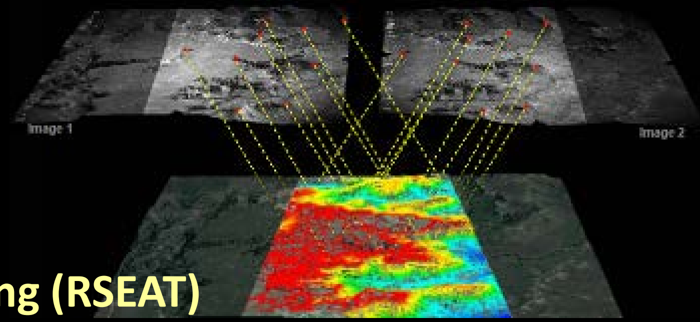
- Chief Information Office
- Human Relations
- Budgeting and Acquisition

Remote Sensing Applications Center (RSAC)

- Detached WO - National Technical Center
- Located in Salt Lake City, Utah
- *Mission:* Provide assistance to agency units and national programs in applying the advanced remote sensing / geospatial technologies for improved inventory, mapping and monitoring of natural resources.

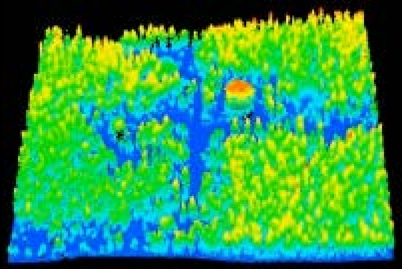


RSAC Organization



- Center Director (Vacant)
- 4 Program areas:
  - Remote Sensing Evaluation, Application & Training (RSEAT)
    - Haans Fisk
  - Resource Mapping, Inventory & Monitoring (RMIM)
    - Kevin Megown
  - Rapid Disturbance Assessment & Services (RDAS)
    - Brad Quayle
  - Enterprise Data & Services (EDS)
    - Dave Vanderzanden

- 10 federal FTEs, ~50 contract staff
  - A blend of highly skilled technical staff - remote sensing, image processing, GIS, IT, and natural resource management



RSAC Core Competencies

- Satellite data processing and analysis
- Geospatial analysis programming
- Resource applications knowledge
- Inventory / RS integration
- Lidar processing and analysis
- Statistical big data analysis
- Project scoping and management
- Training development and delivery
- Software tools and web development
- Geospatial / science communications and design

Accessing RSAC Services

National Steering Committees

- Remote Sensing Steering Committee (RSSC)
- Forest Inventory & Analysis Techniques Research Band (TRB)
- Geospatial Management Advisory Group (GMAG)
- Inventory Monitoring Technology Development Steering Committee (IMTDSC)
- Tactical Fire Remote Sensing Advisory Committee (TFRSAC)

Direct Programmatic Support

- Information Resource Decision Board
- Forest Inventory & Analysis (FIA) Program
- FHP Forest Health Technology Enterprise Team
- Fire & Aviation Management – NIFC
- Burn Area Emergency Response (BAER) Coordinators
- WO CIO Image Processing System, Help desk
- WO Ecosystem Management Coordination

Reimbursable Project Support to USFS Units and Stakeholders

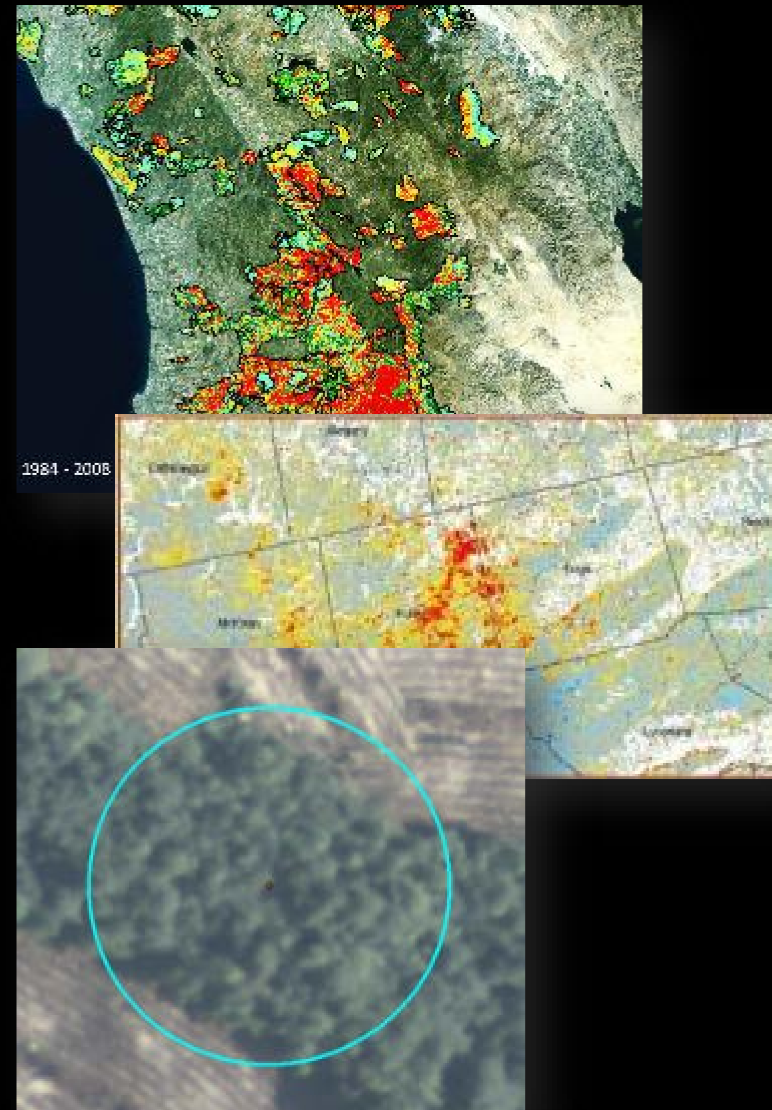
- Technical consultation
- Geospatial data development – cooperative projects
- Acquiring, processing and analyzing imagery
- International geospatial and REDD/REDD+ applications support
- Toolkit and applications development
- Data services

Geospatial Technology & Application Center (GTAC)

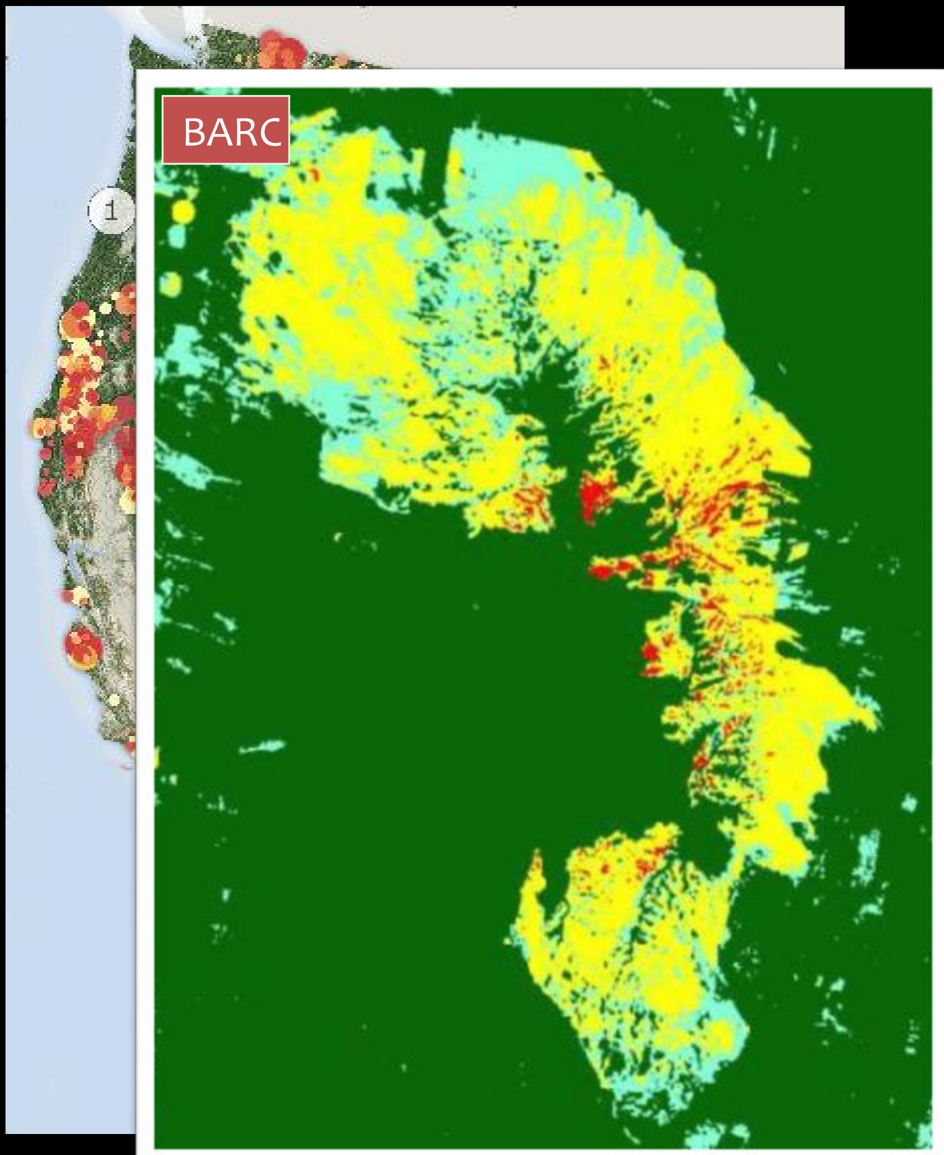
- 2 Geospatial Centers in Salt Lake City
  - Remote Sensing Applications Center (RSAC)
  - Geospatial Service and Technology Center (GSTC)
- Center integration underway – Summer 2016
- “What” is unaffected. “Who/How” may be.
- Minimize Stakeholder Impact

Example RS Monitoring Applications

- Monitoring Trends in Burn Severity (MTBS)
- FHP Real-Time Forest Disturbance (ICE)
- FIA Image-based Change Estimation (RTFD)



Monitoring Trends in Burn Severity (MTBS)



- Location, Extent, Severity
- 1984-Present
- >1000 acres (W), >500 acres (E)
- 30-m Landsat
- Standardized Methods
- Database input from all states, NASF, and all federal agencies

MTBS Data Access

Monitoring Trends in Burn Severity (MTBS)

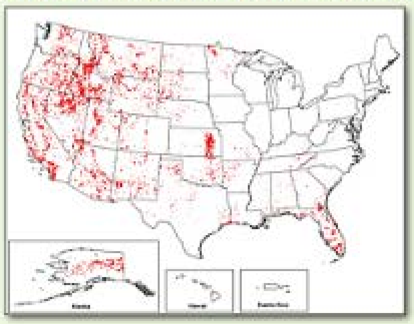
- Home
- What's NEW?
- Background and Partners
- Documents and References
- Methods
- Product Descriptions
- Mapping Status
- Applying MTBS Data
- Project Reports
- Data Access
- Tech Transfer
- Glossary
- Related Websites
- FAQs
- Contact Us

National Geospatial Data

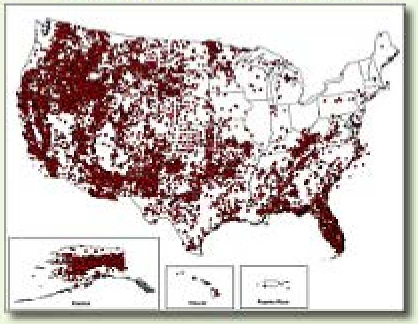
Accessing National MTBS Datasets

National MTBS datasets are accessible via the links below:

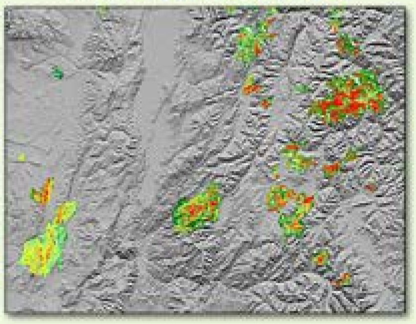
National MTBS Burned Area Boundaries Dataset



National MTBS Fire Occurrence Dataset



National MTBS Burn Severity Mosaics



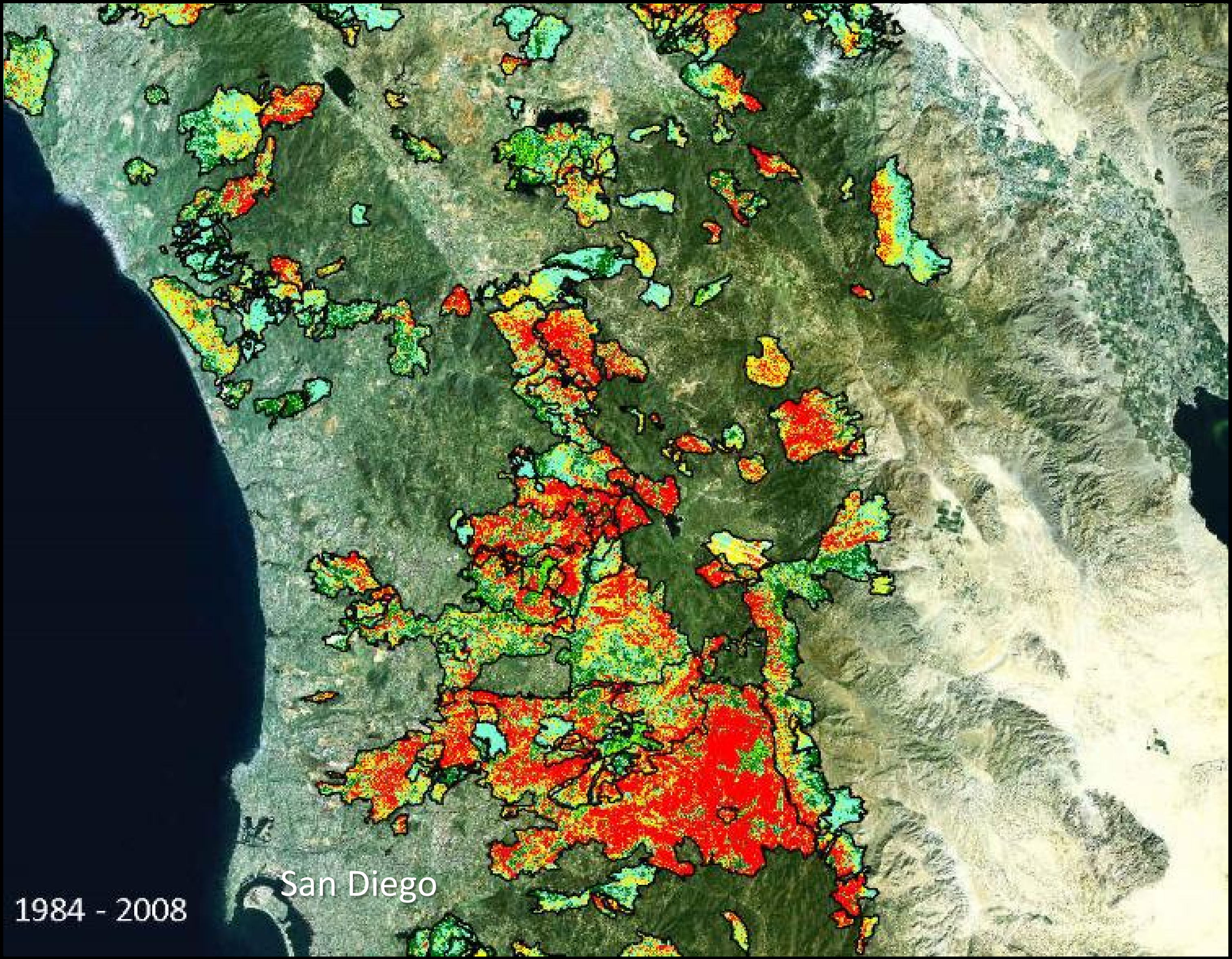
MTBS Map Services

MTBS provides web map services (WMS) as another method to access the national MTBS geospatial datasets. All three types of the seamless national datasets are published as an Open Geospatial Consortium (OGC)-compliant WMS. Please use the WMS Connection URL to access this service within an application. The GetCapabilities URL can also be used to obtain information about the published service.

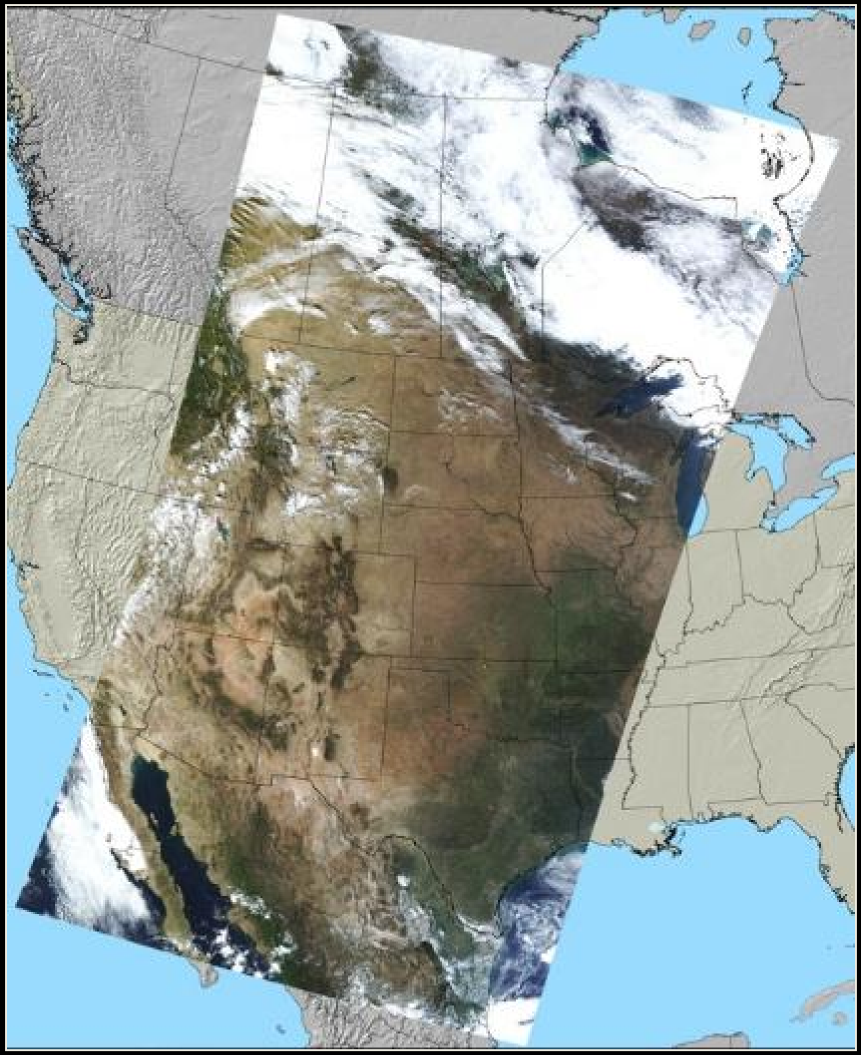
WMS Connection URL:
http://psgeodata.fs.fed.us/arcgis/services/MTBS/MTBS/MapServer/WMSServer

www.mtbs.gov

Monitoring Trends in Burn Severity



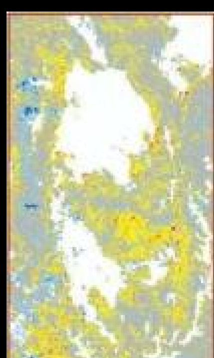
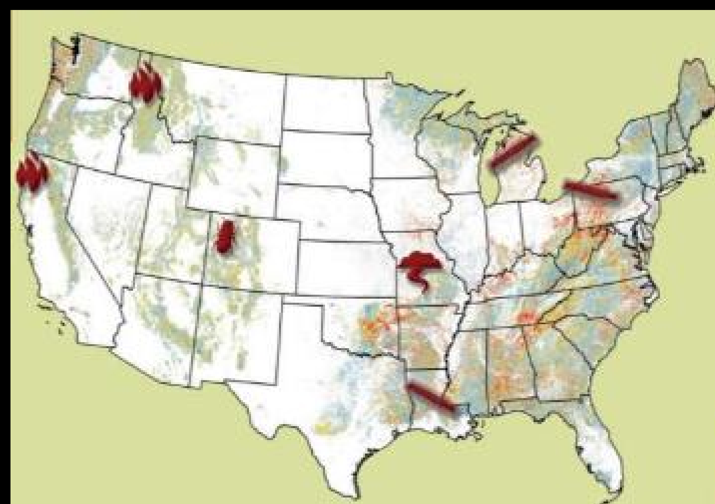
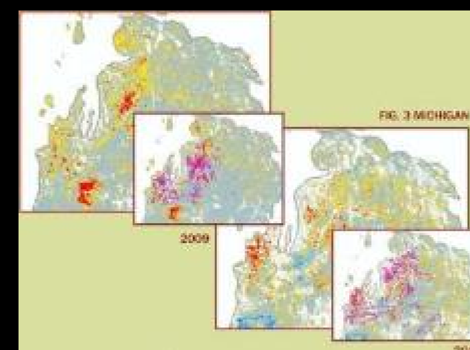
MODIS Real-Time Forest Disturbance (RTFD)

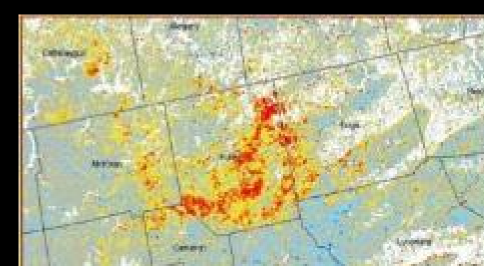


- MODIS Terra and Aqua
- Multispectral (36 bands)
  - 250 meter spatial resolution (red, NIR)
  - 500 meter resolution (blue, green, NIR, SWIR)
- Temporal extent: 2000 - present
- Two daily acquisitions
  - Morning – Terra
  - Afternoon – Aqua
- No cost image data

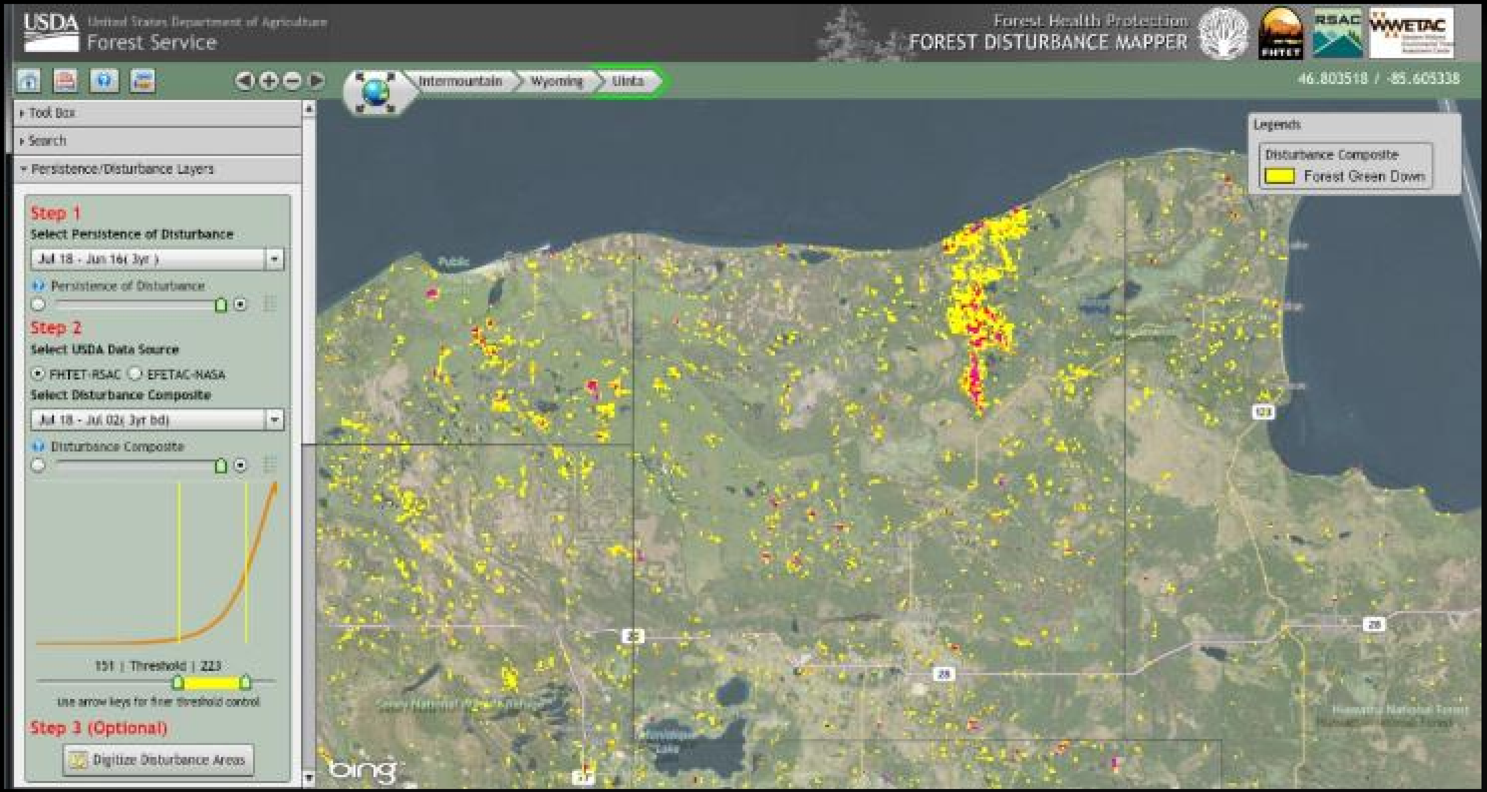
MODIS Real-Time Forest Disturbance (RTFD)

- Both z-Score and Trend methods
- Timely information to forest health community
- New change maps every 8 days (growing season)



Forest Disturbance Monitor (FDM)



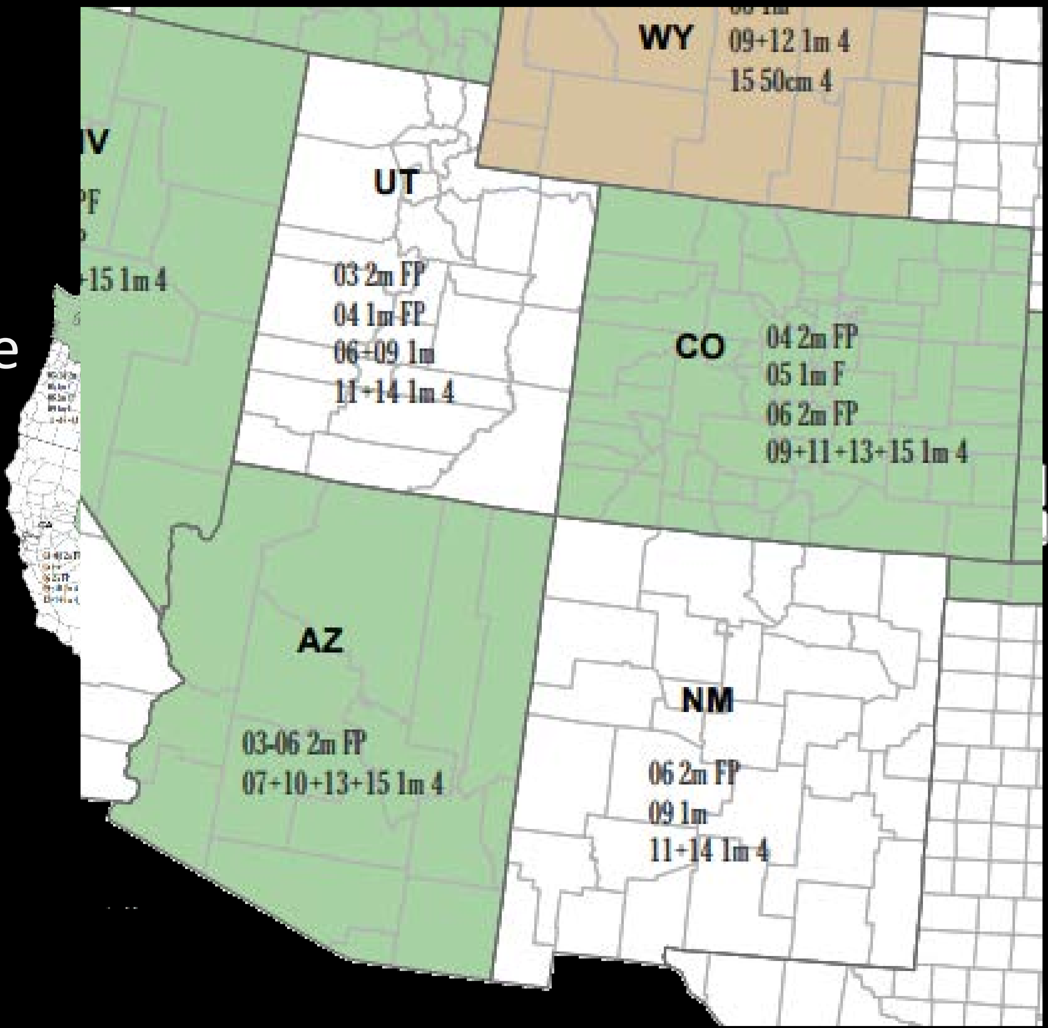
- Web tools to support forest insect and disease survey
- Broad level early warning system
- Rapid evaluation of large areas for potential forest disturbance activity
- User adjusted disturbance data
- User created shape files for easily download / reporting / field verification
- http://foresthealth.fs.usda.gov

Image-based Change Estimation (ICE)

- FIA / RSAC Collaboration
- Image based estimation of land cover and land use change
- Separate Attribution of
  - Land Use
  - Land Cover
  - Change Agent
- Augments FIA field data
- Process easily adapted

Leverage NAIP Imagery

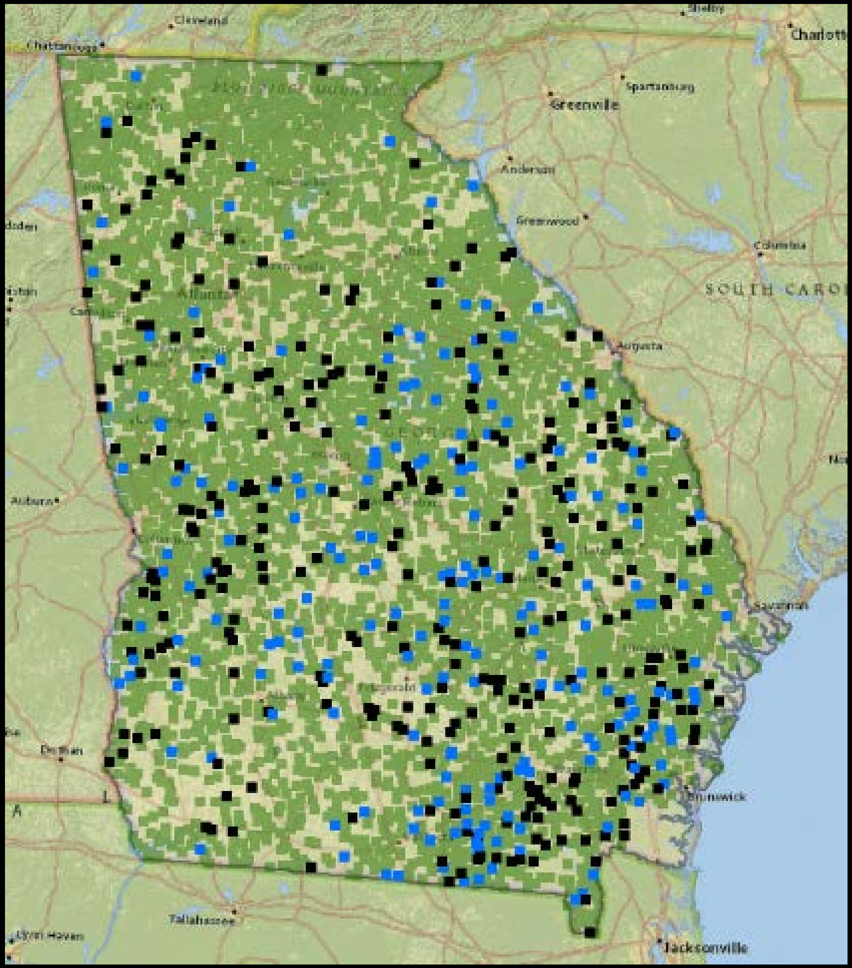
- Annual Federal Investment
- 2-3 year acquisition schedule
- 0.5-1.0 m resolution
- Natural color or 4-Band

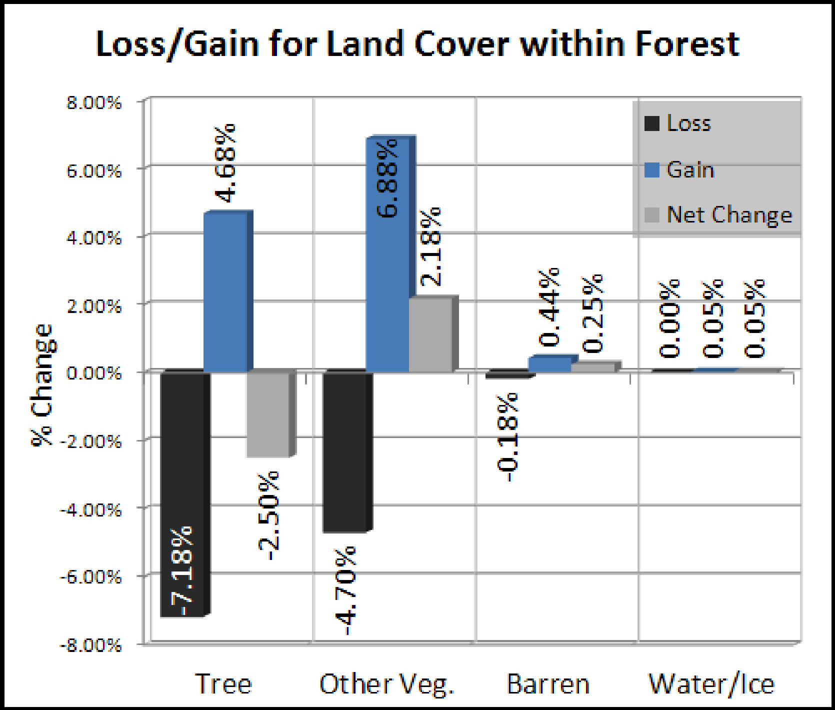


USDA

Quick Analysis – Broad Area Assessment

Tree Cover Loss/Gain





USDA

Thank you!

Resource Mapping, Inventory & Monitoring (RMIM)

- **Kevin Megown**, kamegown@fs.fed.us, 801-975-3726

Remote Sensing Evaluation, Application & Training (RSEAT)

- **Haans Fisk**, hfisk@fs.fed.us, 801-975-3760

Rapid Disturbance Assessment & Services (RDAS)

- **Brad Quayle**, bquayle@fs.fed.us, 801-975-3737

Enterprise Data & Services (EDS)

- **Dave Vanderzanden**, dvanderzanden@fs.fed.us, 801-975-3753

RedCastle Resources

- **Mark Finco**, mfinco@fs.fed.us, 801-975-3767
- **Paul Maus**, pmaus@fs.fed.us, 801-975-3756