Broader-scale Monitoring

PROJECT UPDATE: TEAM WORK, INTERVIEWS & WORKSHOPS

Broader-scale monitoring strategy

- Responsibility lies with Regional Forester
- Directed to address forest plan monitoring questions best answered at a geographic scale broader than one plan area
- Can be developed in cooperation with partners
- Must be feasible and complement other monitoring efforts (36 CFR 219.9)

R2/ R3 Broader-scale Monitoring Project

The BSMS project includes the following phases:

Project team work by USFS Regional and Washington Office staff, Rocky Mountain Research staff, SWERI staff

Interviews conducted with stakeholders, Forest Service staff, external agency partners, and other monitoring experts.

Workshops to further develop the BSMS strategy.

Final report and recommendations on the process and framework for the BSMS in Regions 2 and 3.

BSMS project interviewees

General Group of Interviewees	Final Interviewee Totals
NGOs	13
Other Federal Land Management Or Regulatory Agencies	20
State Agencies	9
Forest Service: Total	47
National Staff	5
Regional Staff	17
Forest Level Staff	20
Research Station Staff	5
Academic Partners	4
Totals	93

The Nature Conservancy
The Wilderness Society
Defenders of Wildlife
Western Watersheds Project
Conservation Science Partners
Forest Guild
Rocky Mountain Bird Observatory

US Fish & Wildlife Service
National Park Service
Bureau of Land Management
US Geologic Survey
Natural Resources Conservation Service
Bureau of Reclamation
Environmental Protection Agency

State Fish and Wildlife
Natural Heritage Programs
State Forestry

Broad-scale Monitoring Goals
Project Team

Better inform forest-level decisions

Improve coordination of monitoring efforts

Broad-scale Monitoring Goals

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

Improve coordination of monitoring efforts

Broad-scale Monitoring Goals

Better inform forest-level decisions

Improve coordination of monitoring efforts

- Identify questions best answered at geographic scales greater than one forest
- Create a more systematic and unified monitoring approach to test management effectiveness
- Leverage resources via multi-party monitoring resources including all FS branches, other government agencies, non-government agencies, and the public
- Identify a feedback mechanism (I.e. a process of adaptive management) to improve effectiveness and efficiency of broader-scale monitoring
- Provide opportunities to communicate broad trends across NFS lands to a variety of stakeholders

BSMS – Potential Benefits
Interview Results

- Improve consistency and coordination
- Increase efficiency and quality
- Increase coordination and understanding across land management jurisdictions, supporting an "all-lands" approach to land management
- Facilitate more effective partnerships
- Be an effective communication tool

Broad-scale Monitoring Goals
Workshops-to-date

"Broader-scale Monitoring is…"

Acknowledged Challenges

Broad-scale Monitoring Goals
Workshops-to-date

"Broader-scale Monitoring is…"

- A RF strategy for geographic **scales greater than 2 national forests**
- **Measuring progress towards desired conditions** and informing USFS decision makers
- *Working towards* **consistent indicators and methods** and the ability to synthesize information in a consistent manner **across temporal and spatial scales**
- Linked to USFS 2012 planning rule **forest-level planning** and required "Big 8"
- *Working towards* increasing efficiency by **coordinating with partners**
- Ideally drawing upon **existing monitoring efforts**, unless a critical gap needs to be addressed
- **Scalable** to national levels (variable-dependent)

Acknowledged Challenges

Broad-scale Monitoring Goals
Workshops-to-date

"Broader-scale Monitoring is…"

Acknowledged Challenges

- **Timing** of USFS plan revision work to meet 2012 Planning Rule
  - Forests using 1982 plan revision processes
  - Monitoring transition work
  - Forests using 2012 Planning Rule plan revision processes
- **Lack of additional funding** for regionally-supported monitoring

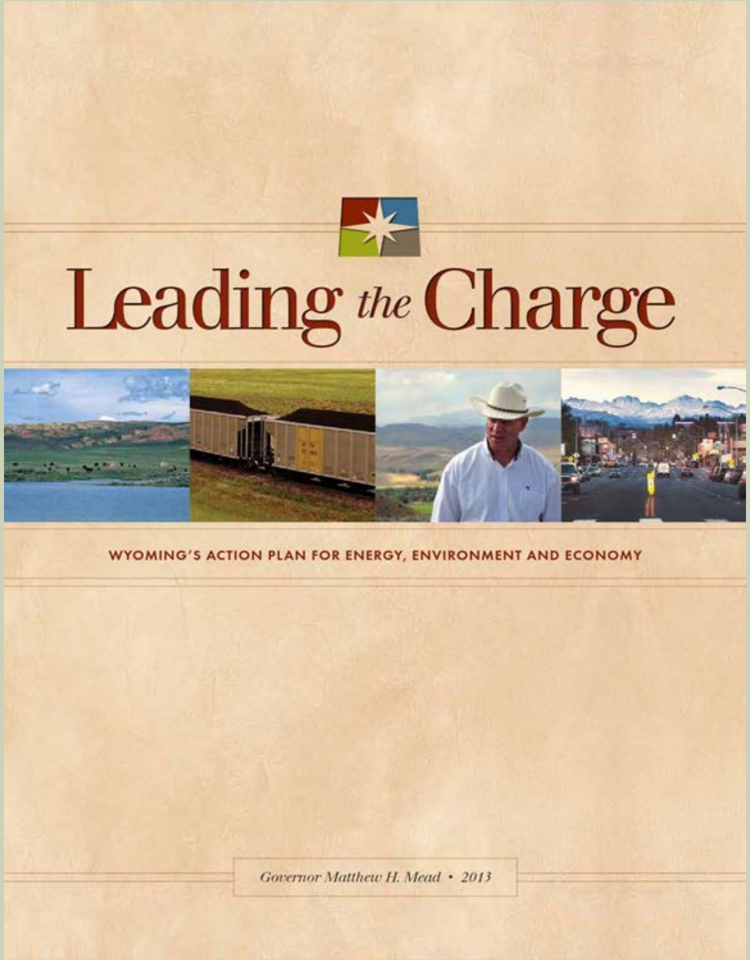
Thanks for participating

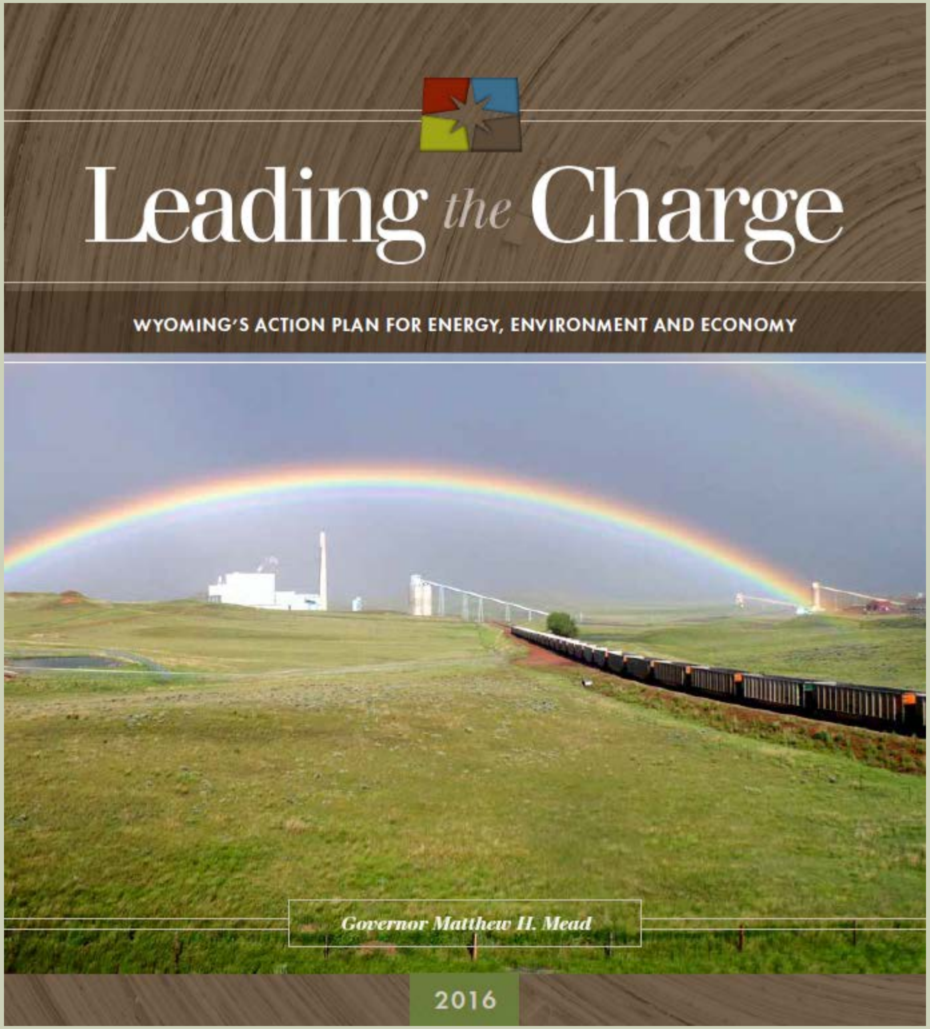
GOVERNOR'S TASK FORCE ON FORESTS

Jessica Crowder
Policy Advisor

Office of Governor Matthew H. Mead

ENERGY STRATEGY





ENERGY STRATEGY

- 2013 Energy Strategy

"Removing dead trees from forests in Wyoming will improve forest conditions. Converting trees to fuel or salable products could provide and economic benefit to local communities. Recommendations will be proposed for using beetle killed timber in energy production and in other ways."

- 2016 Energy Strategy

GOVERNOR'S TASK FORCE ON FORESTS

- 2013

- 20 members

- Focus on three themes

1) Fire and other disturbance
2) Forest management
3) Economic opportunities and innovation

- Final Report and Recommendations – January 2015
- 12 Recommendations and 53 Sub-recommendations

GOVERNOR'S TASK FORCE ON FORESTS

- Invasive species
- Recommendation 4: In partnership with federal agencies, support increased funding to prevent, detect, and control non-native invasive plants, wildlife, and insects that threaten the health of Wyoming forests.

GOVERNOR'S TASK FORCE ON FORESTS

- **http://arcg.is/1V2sHsQ**

GOVERNOR'S TASK FORCE ON FORESTS

- Invasive species
- Education Efforts

Play Clean Go™

STOP INVASIVE SPECIES IN YOUR TRACKS.

PlayCleanGo.org

GOVERNOR'S TASK FORCE ON FORESTS

- Fire and Other Disturbances

- Recommendation 3.9: Develop cross-jurisdictional watershed protection plans for municipal water supply drainages that focus on proactive management to preserve and enhance water quality, and to avoid catastrophic effects large-scale fires have on municipal watersheds.

- Two studies
  - Cheyenne
  - Buffalo

GOVERNOR'S TASK FORCE ON FORESTS

- Wyoming Forest Action Plan
- State Forestry develops, updates and utilizes Wyoming's Forest Action Plan to determine priorities
  - Prioritizes fuels projects to protect communities and/or resources at risk
  - Firewise Communities
  - Cheatgrass projects on areas burned by wildfire in 2012
  - BLM/USFS/State Partnership Forester in Rawlins/Saratoga area
  - NRCS/Wild Turkey Foundation/State Partnership Forester in the Black Hills

GOVERNOR'S TASK FORCE ON FORESTS

- State Forestry Efforts
  - Pole Mountain fuels project
  - Bark beetle mitigation funds
    - Used for beetle mitigation and fuels reduction on federal, state and private lands in several areas:
      - Black Hills
      - Bighorns
      - Medicine Bow
      - Uinta
      - Bridger-Teton

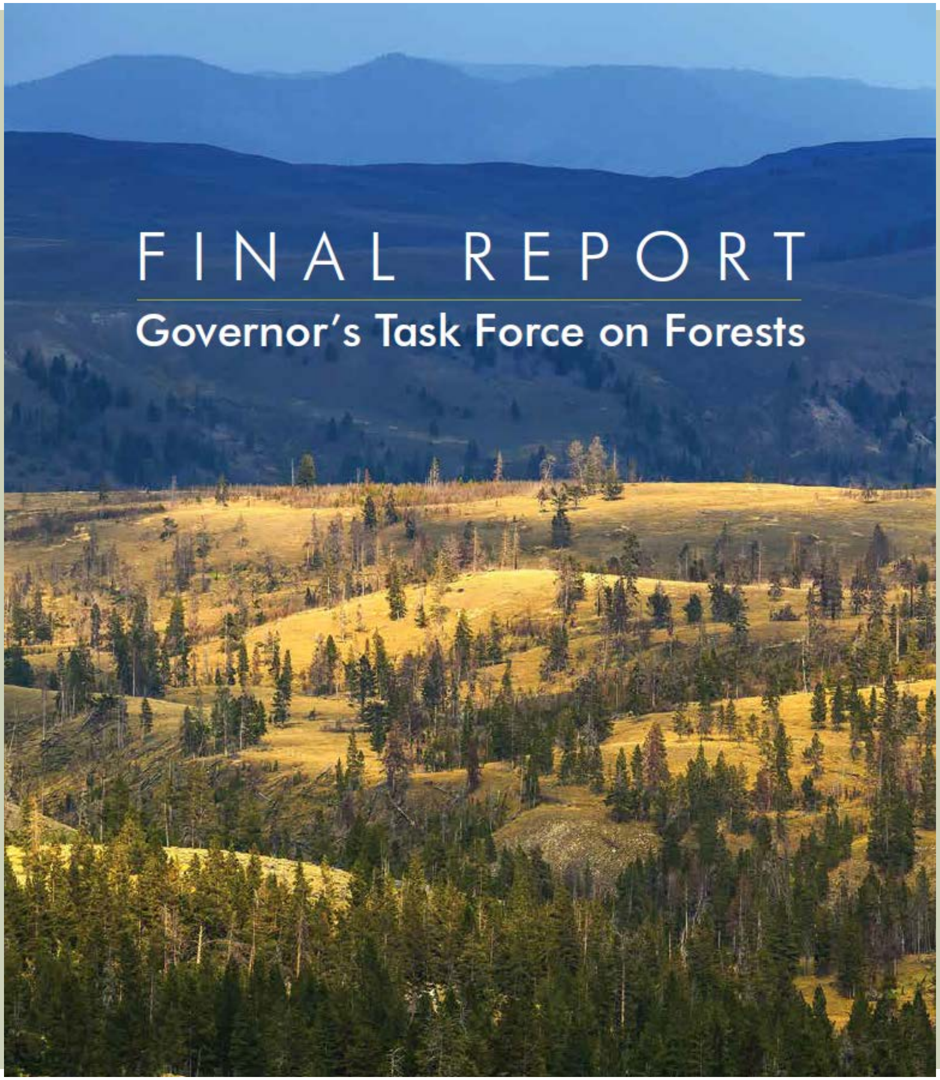
GOVERNOR'S TASK FORCE ON FORESTS

- Recommendation 2: Facilitate the creation of local collaborative working groups to address local forest management issues.

- Forest Collaborative Assistance Program

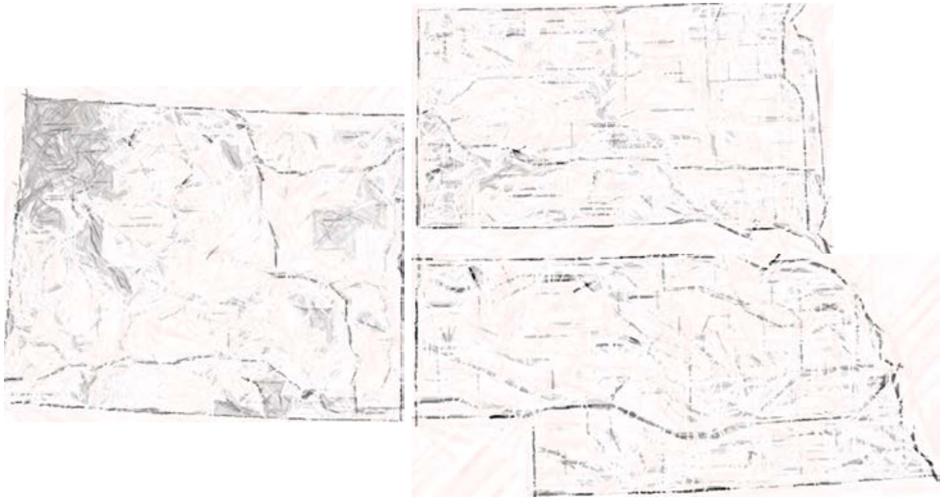
GOVERNOR'S TASK FORCE ON FORESTS

- http://governor.wyo.gov/

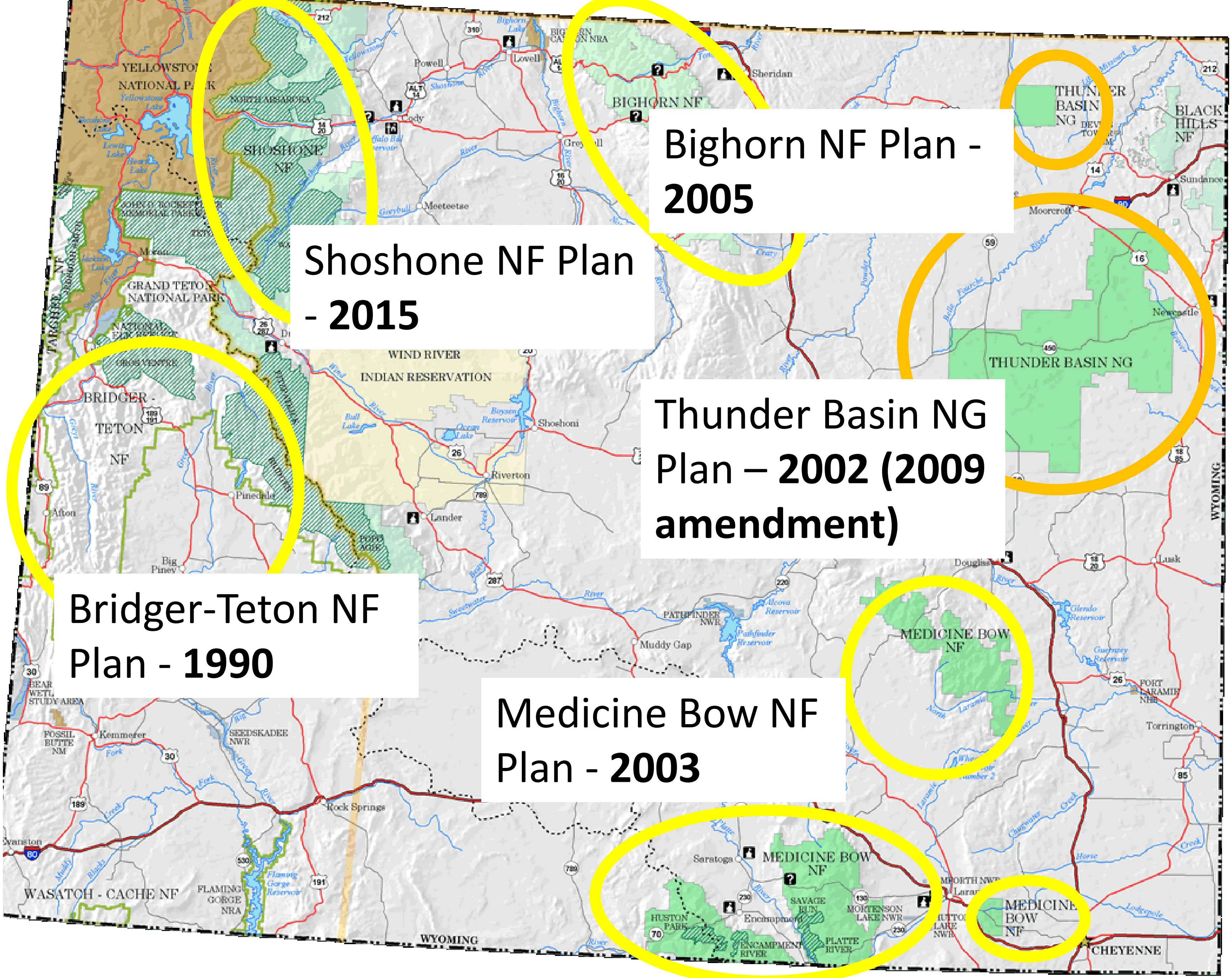


Broader Scale Monitoring and Forest Planning

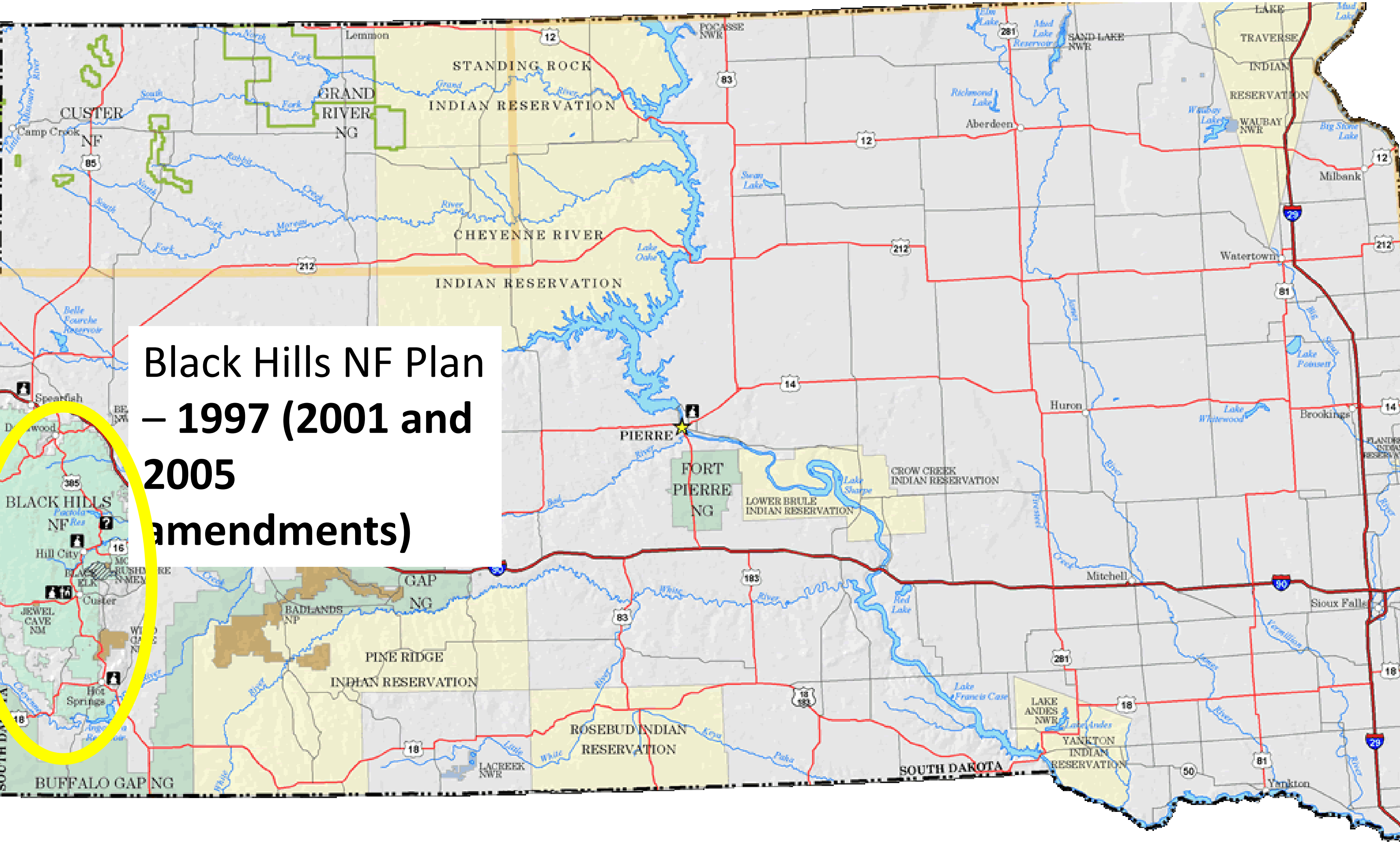
Laramie- May2016

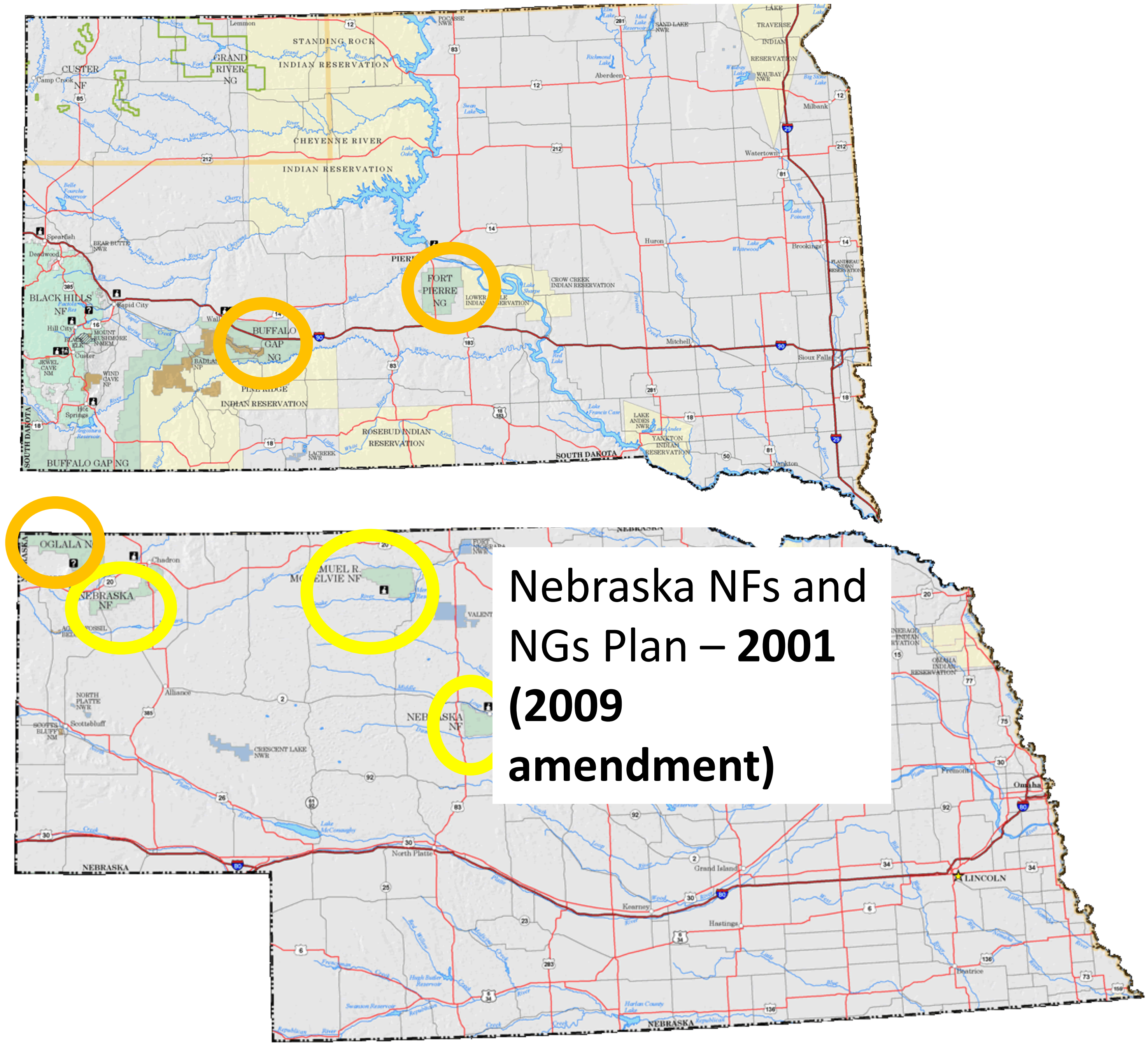


Trey Schillie - Regional Inventory, Monitoring, and Climate Change Coordinator


Bighorn NF Plan - 2005
Shoshone NF Plan - 2015
Thunder Basin NG Plan – 2002 (2009 amendment)
Bridger-Teton NF Plan - 1990
Medicine Bow NF Plan - 2003
YELLOWSTONE NATIONAL PARK
SHOSHONE NF
BIGHORN NF
THUNDER BASIN NG
BLACK HILLS NF
GRAND TETON NATIONAL PARK
WIND RIVER INDIAN RESERVATION
BRIDGER - TETON NF
MEDICINE BOW NF
WASATCH - CACHE NF
FLAMING GORGE NRA
SEEDSKADEE NWR
PATHFINDER NWR
CHEYENNE
WYOMING

Black Hills NF Plan – **1997 (2001 and 2005 amendments)**




Nebraska NFs and NGs Plan – **2001 (2009 amendment)**

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

Laramie- May 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 visibility?*

  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
- Take advantage of existing programs and monitoring efforts

Broader-scale Monitoring

RELEVANCE FOR FOREST PLANNING

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

Forest Plan Monitoring Aspects

Current Forest monitoring challenges

- Most monitoring is at the project level
- Lack of capacity for effective monitoring design and **analysis**
- Often status, not robust trend

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

Indicator categories

	Remote-Assessment Indicators
Purpose	Indicate status of key ecological attributes at larger spatial scales and/or at coarser spatial resolution
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
Examples	Landscape Metrics – Patch size, heterogeneity, composition, connectivity from Landsat Forest structure (LIDAR) Aerial surveys for insect and disease

Indicator categories

	Rapid-Assessment Indicators
Purpose	Indicate status of key ecological attributes at intermediate to fine spatial scales or spatial resolution; multiple measurement locations can provide wide spatial coverage
Data source	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
Examples	Weather stations (snowtel) Stream flow monitoring Vegetation structure (qualitative) e.g PFC Photo-point

Indicator categories

	Intensive-Assessment Indicators
Purpose	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	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	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) Substrategy: 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

Common Forest plan monitoring questions

Forest vegetation

What are the status and trends of forest vegetation over time (structure, composition, spatial heterogeneity)?

How are major vegetation types on the planning unit changing over time?

Common Forest plan monitoring questions

Wildlife (species and habitat)

What are the status and trends of species (e.g. black tailed prairie dogs)

What is the status and trend of early successional conifer and late seral spruce-fir forests to promote recovery of Canada lynx?

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

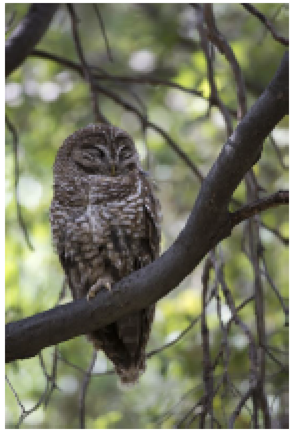
MSO Recovery Plan

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

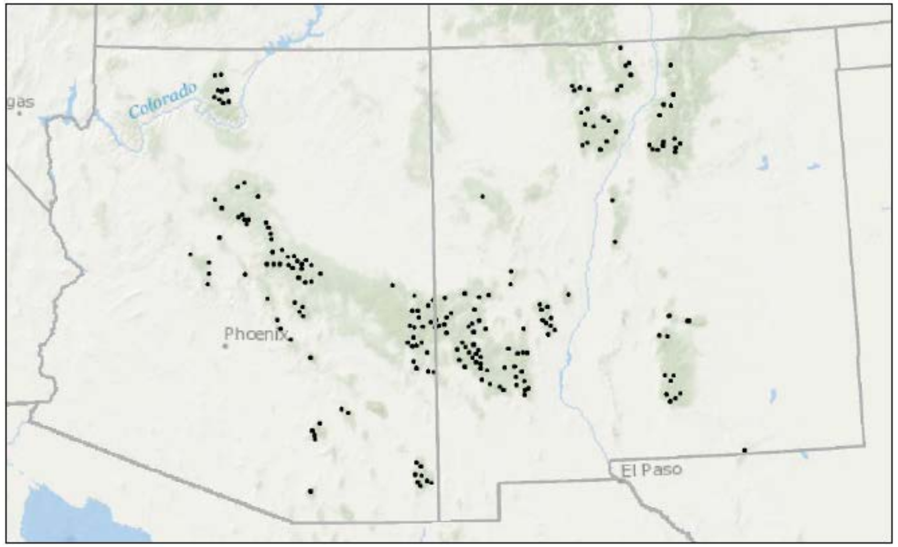
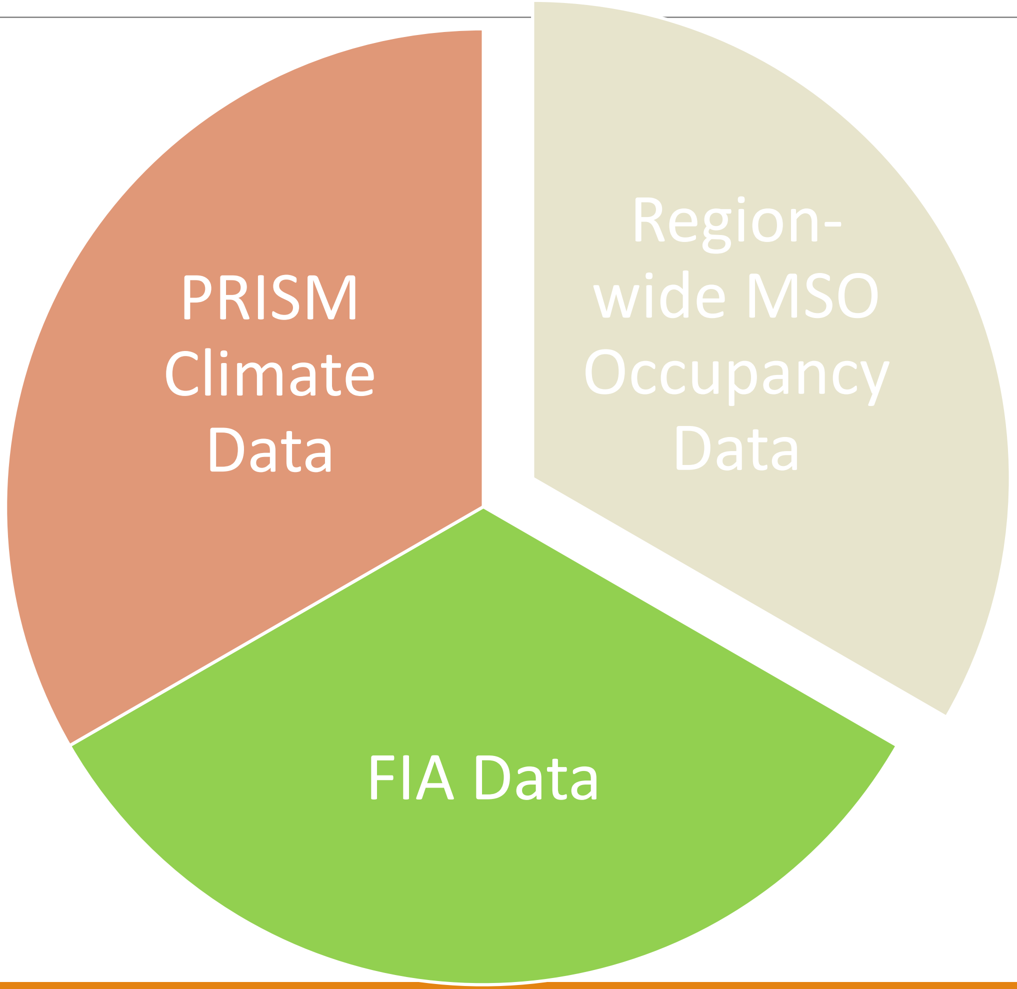


Figure 1. The distribution of sampling units (*n = 201*) surveyed for Mexican Spotted Owl occupancy in 2015 in the US Forest Southwestern Region.

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?

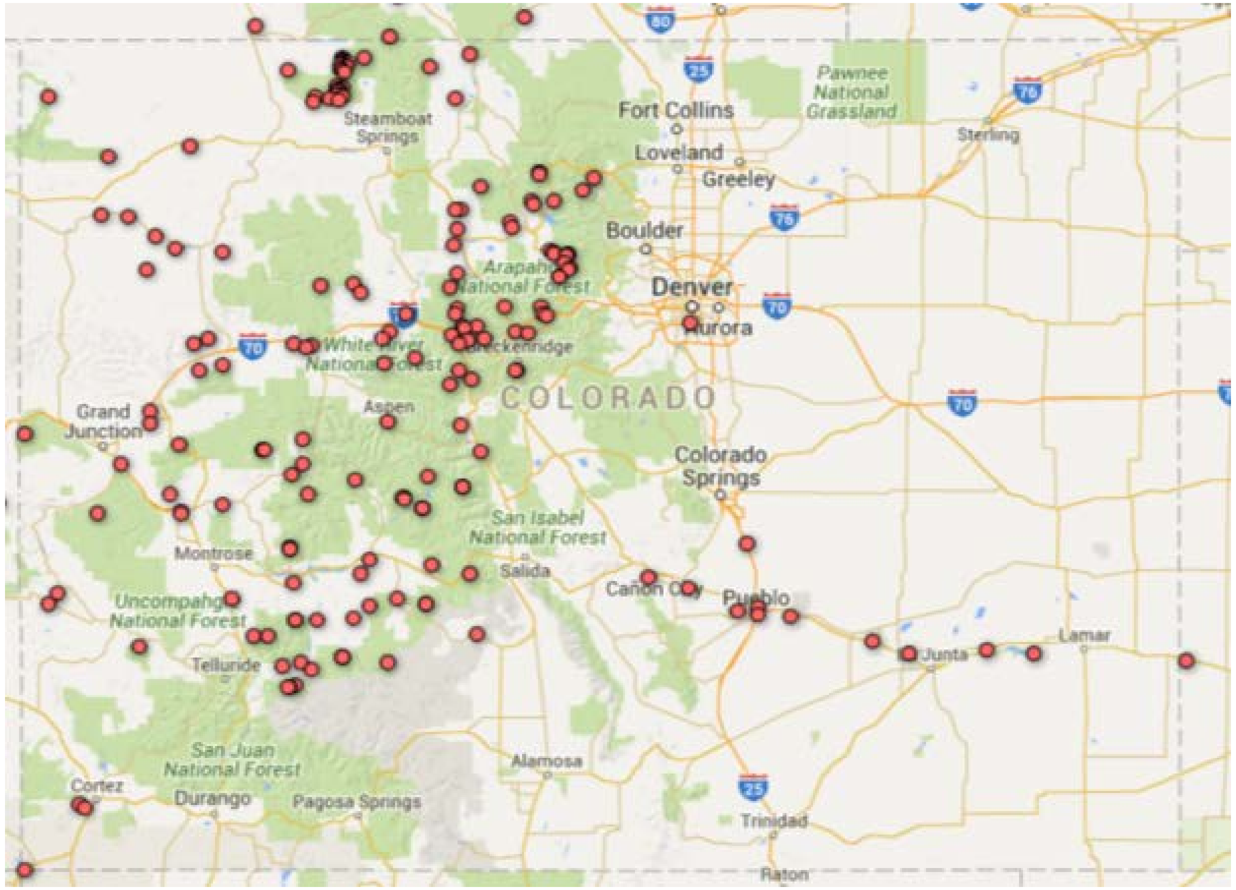
Common Forest plan monitoring questions

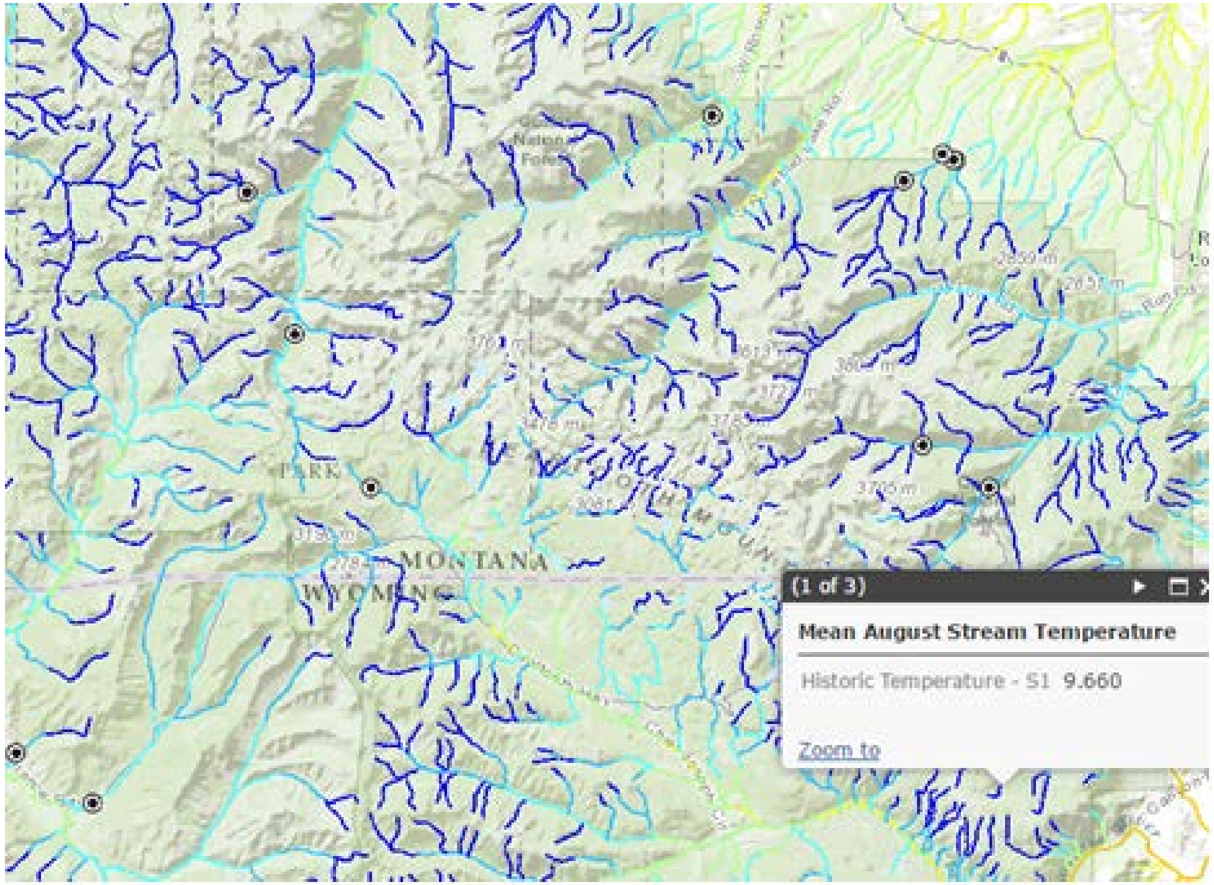
Watershed, Riparian, Aquatic

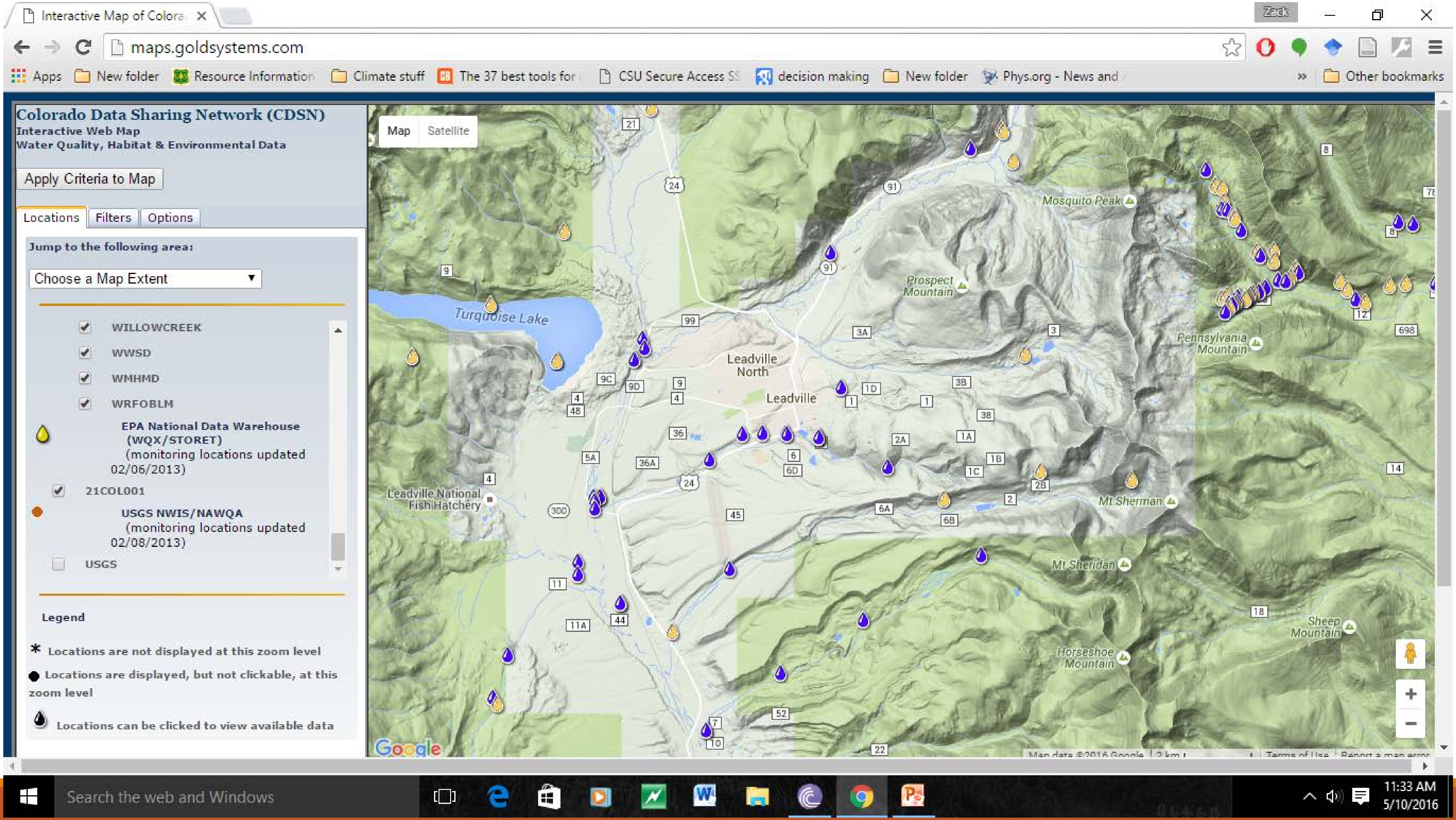
What are watershed conditions and trends on the planning unit (stream flow, temperature, etc.)?

Is the unit improving condition in priority watersheds?

Existing BSMS: NORWEST stream temperature monitoring







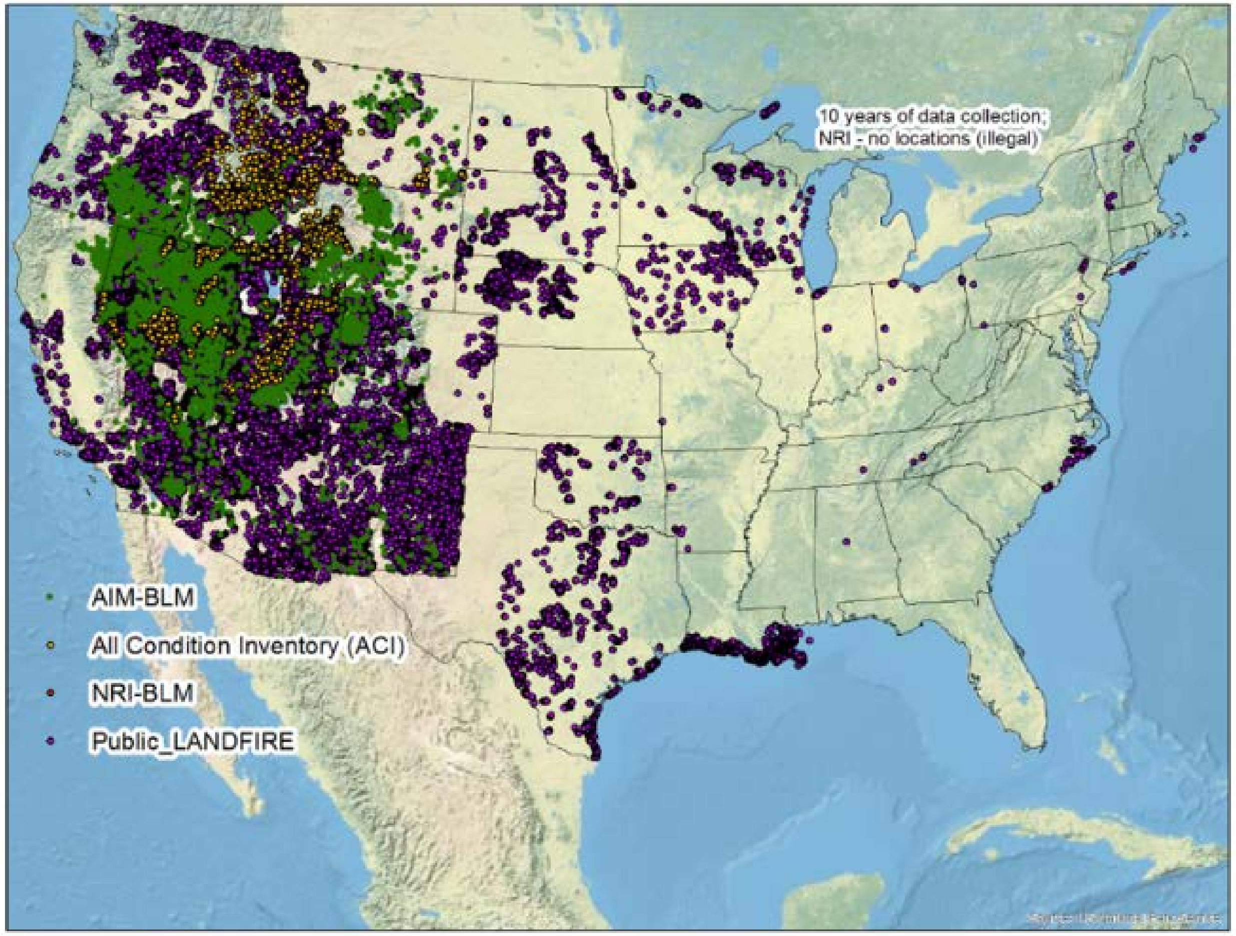
Interactive Map of Colora
maps.goldsystems.com
Colorado Data Sharing Network (CDSN)
Interactive Web Map
Water Quality, Habitat & Environmental Data
Apply Criteria to Map
Locations
Filters
Options
Jump to the following area:
Choose a Map Extent
WILLOWCREEK
WWSD
WMHMD
WRFOBLM
EPA National Data Warehouse (WQX/STORET) (monitoring locations updated 02/06/2013)
21COL001
USGS NWIS/NAWQA (monitoring locations updated 02/08/2013)
USGS
Legend
Locations are not displayed at this zoom level
Locations are displayed, but not clickable, at this zoom level
Locations can be clicked to view available data
Map
Satellite
Turquoise Lake
Leadville North
Leadville
Mosquito Peak
Prospect Mountain
Pennsylvania Mountain
Leadville National Fish Hatchery
Mt Sherman
Mt Sheridan
Sheep Mountain
Horseshoe Mountain
Search the web and Windows
11:33 AM
5/10/2016

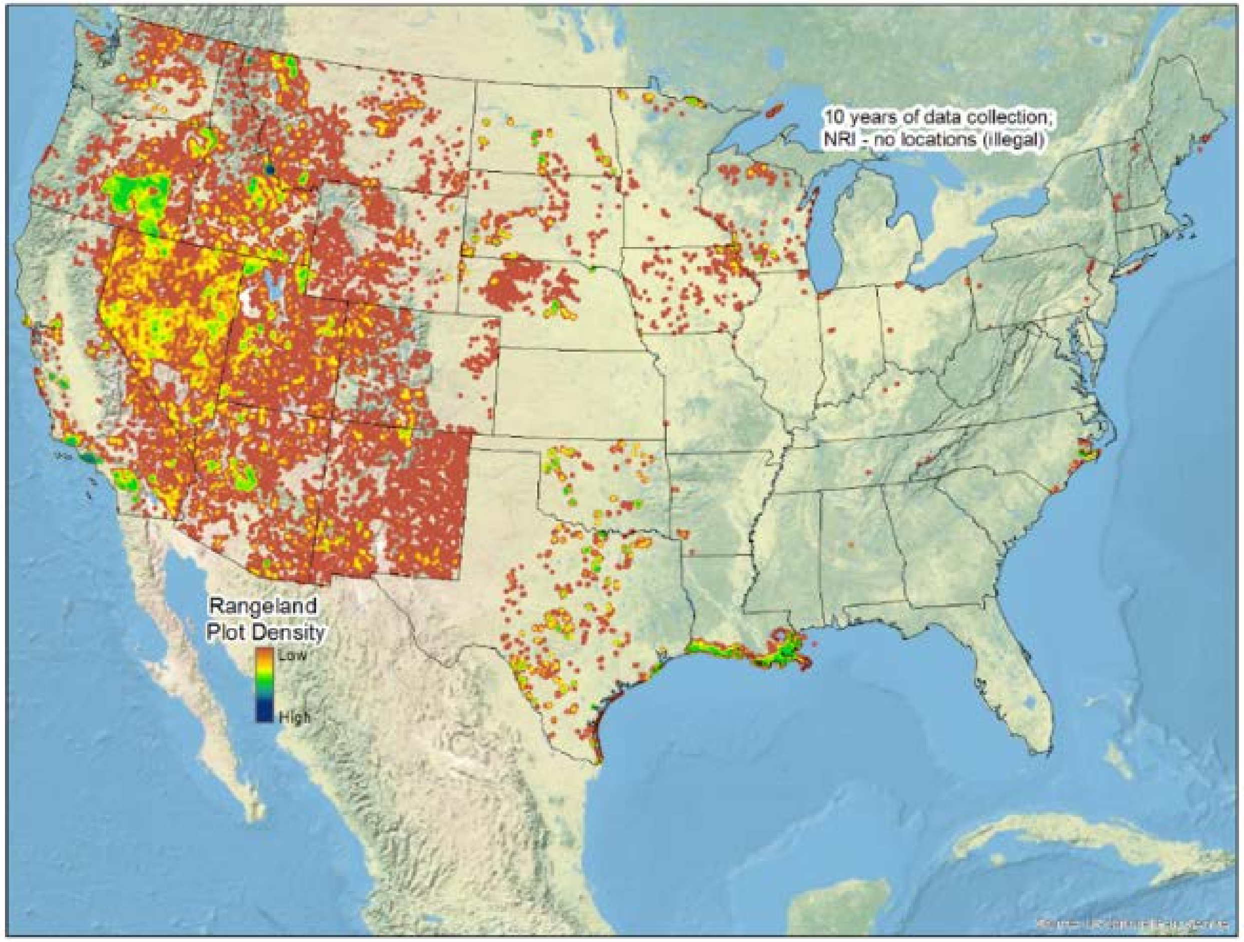
Common Forest plan monitoring questions

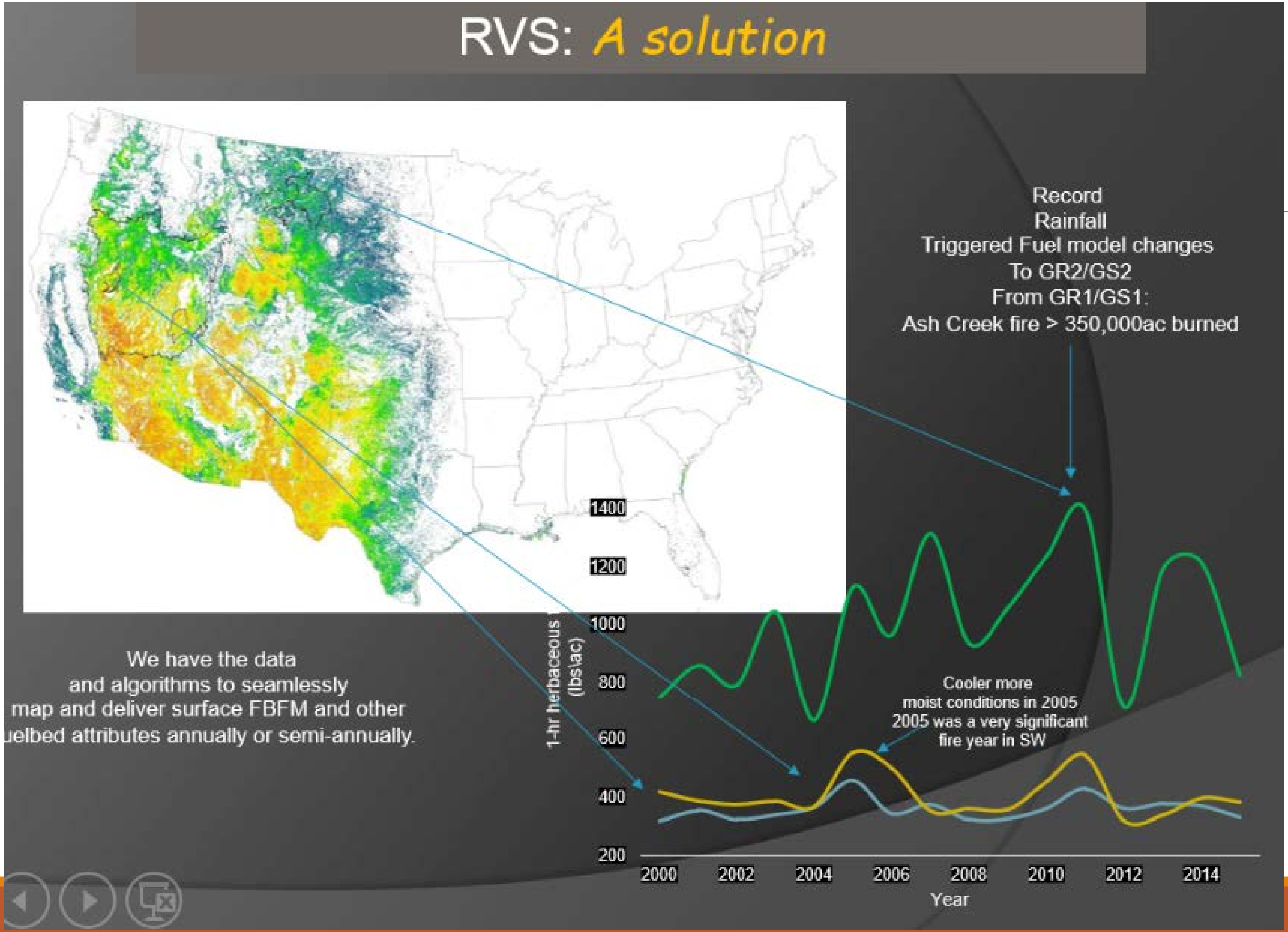
Range/invasives

What is the status and trend of rangeland vegetation condition?

What are the status and trends of select terrestrial invasive species?


10 years of data collection;
NRI - no locations (illegal)
AIM-BLM
All Condition Inventory (ACI)
NRI-BLM
Public_LANDFIRE


10 years of data collection;
NRI - no locations (illegal)
Rangeland
Plot Density
Low
High

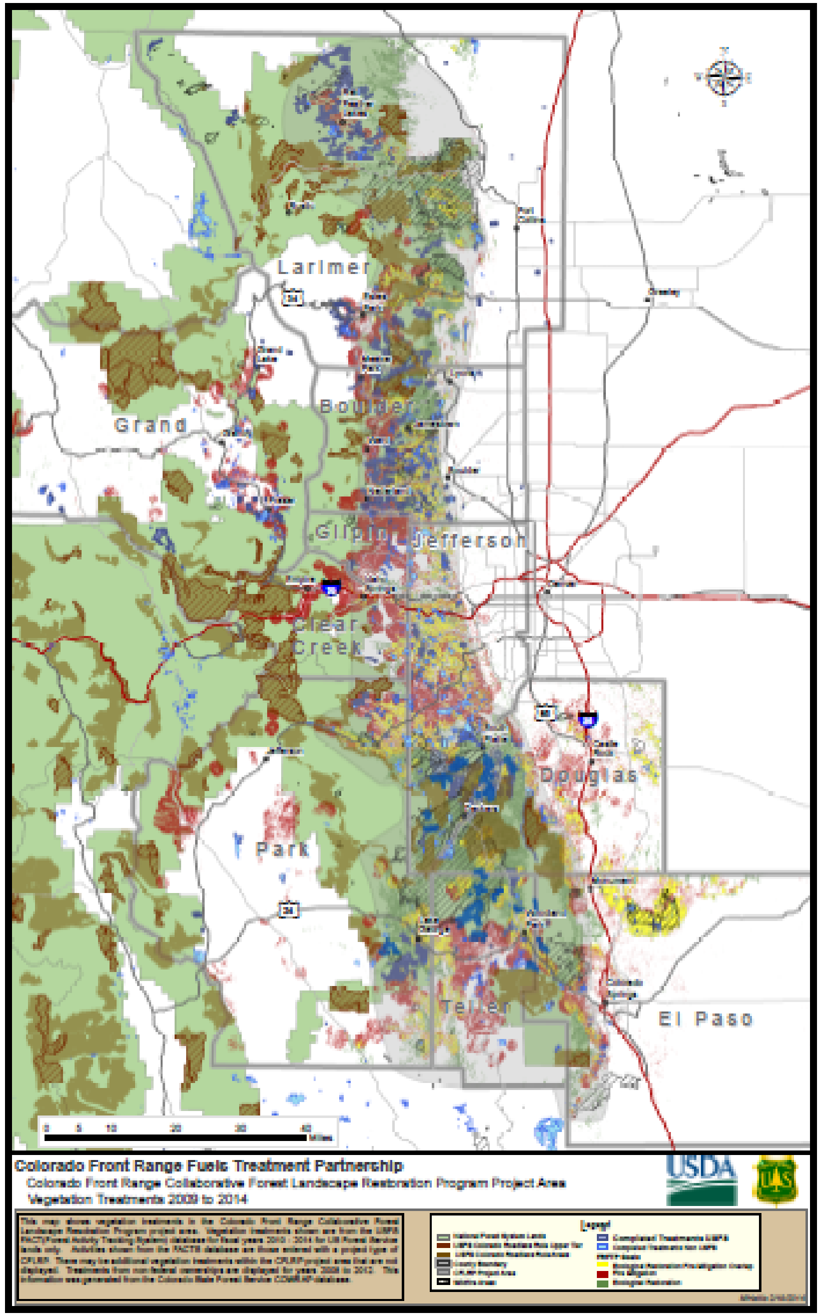

RVS: A solution
Record
Rainfall
Triggered Fuel model changes
To GR2/GS2
From GR1/GS1:
Ash Creek fire > 350,000ac burned
We have the data
and algorithms to seamlessly
map and deliver surface FBFM and other
uelbed attributes annually or semi-annually.
Cooler more
moist conditions in 2005
2005 was a very significant
fire year in SW
1-hr herbaceous
(lbs\ac)
1400
1200
1000
800
600
400
200
2000
2002
2004
2006
2008
2010
2012
2014
Year

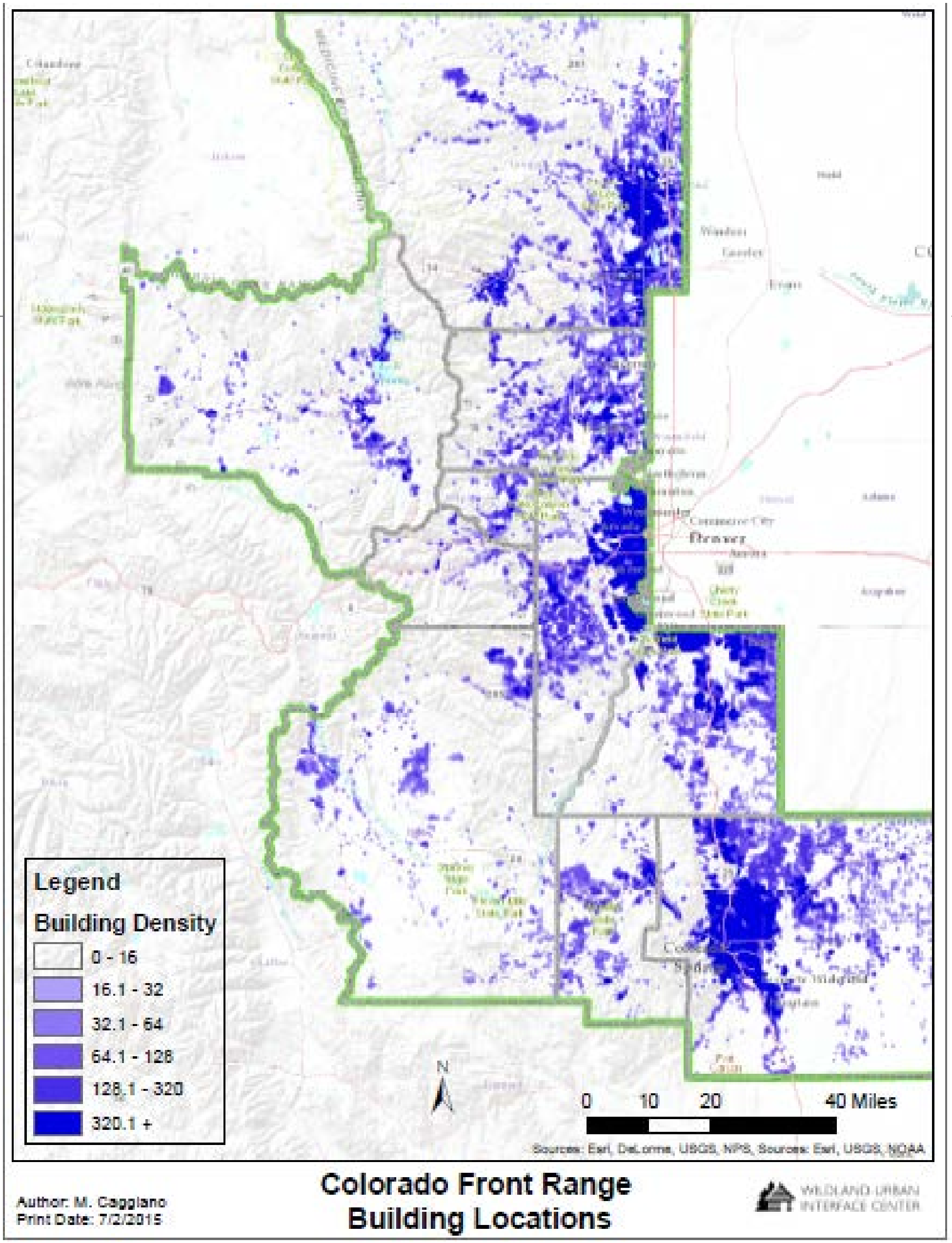
Common Forest plan monitoring questions

Socioeconomic

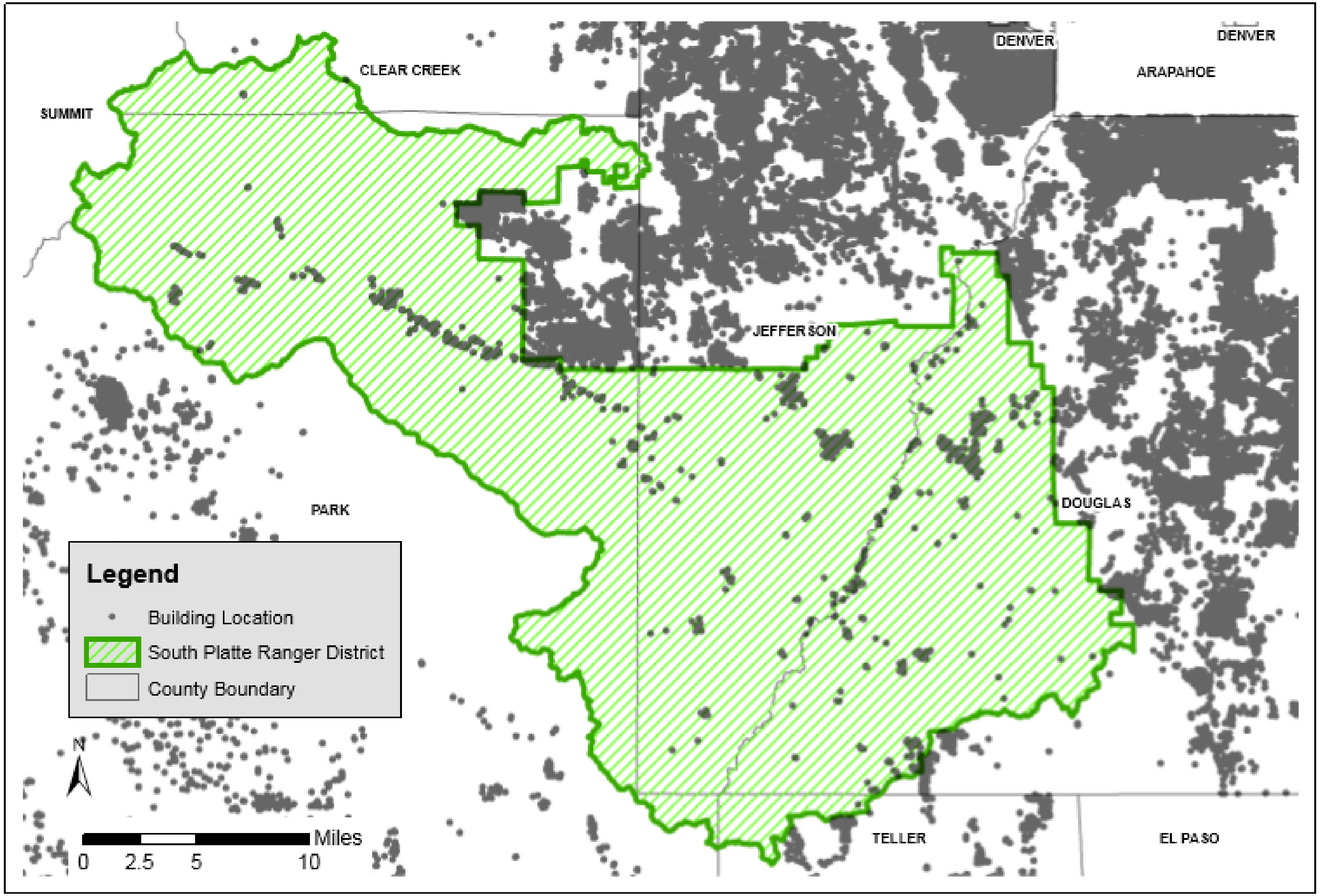
What are the contributions from the range, timber, recreation, and minerals program from the National Forest or Grassland?

What are the status and trends of visitor satisfaction for recreational visits on the planning unit?


Larimer
Grand
Boulder
Gilpin
Jefferson
Clear Creek
Douglas
Park
Teller
El Paso
Colorado Front Range Fuels Treatment Partnership
Colorado Front Range Collaborative Forest Landscape Restoration Program Project Area
Vegetation Treatments 2009 to 2014
USDA


Legend
Building Density
0 - 16
16.1 - 32
32.1 - 64
64.1 - 128
128.1 - 320
320.1 +
N
0 10 20 40 Miles
Sources: Esri, DeLorme, USGS, NPS, Sources: Esri, USGS, NOAA
Author: M. Caggiano
Print Date: 7/2/2015
Colorado Front Range
Building Locations
WILDLAND URBAN INTERFACE CENTER

Building Locations on the South Platte Ranger District



Author: M. Caggiano
Print Date: 1/21/2016
Notes: No warranties are made as to the accuracy of data depicted in map.

1602 buildings are within the district boundary
2592 buildings are within .25 miles of the district boundary

Resource specific issues

Forest/veg (req. 2 and 7)

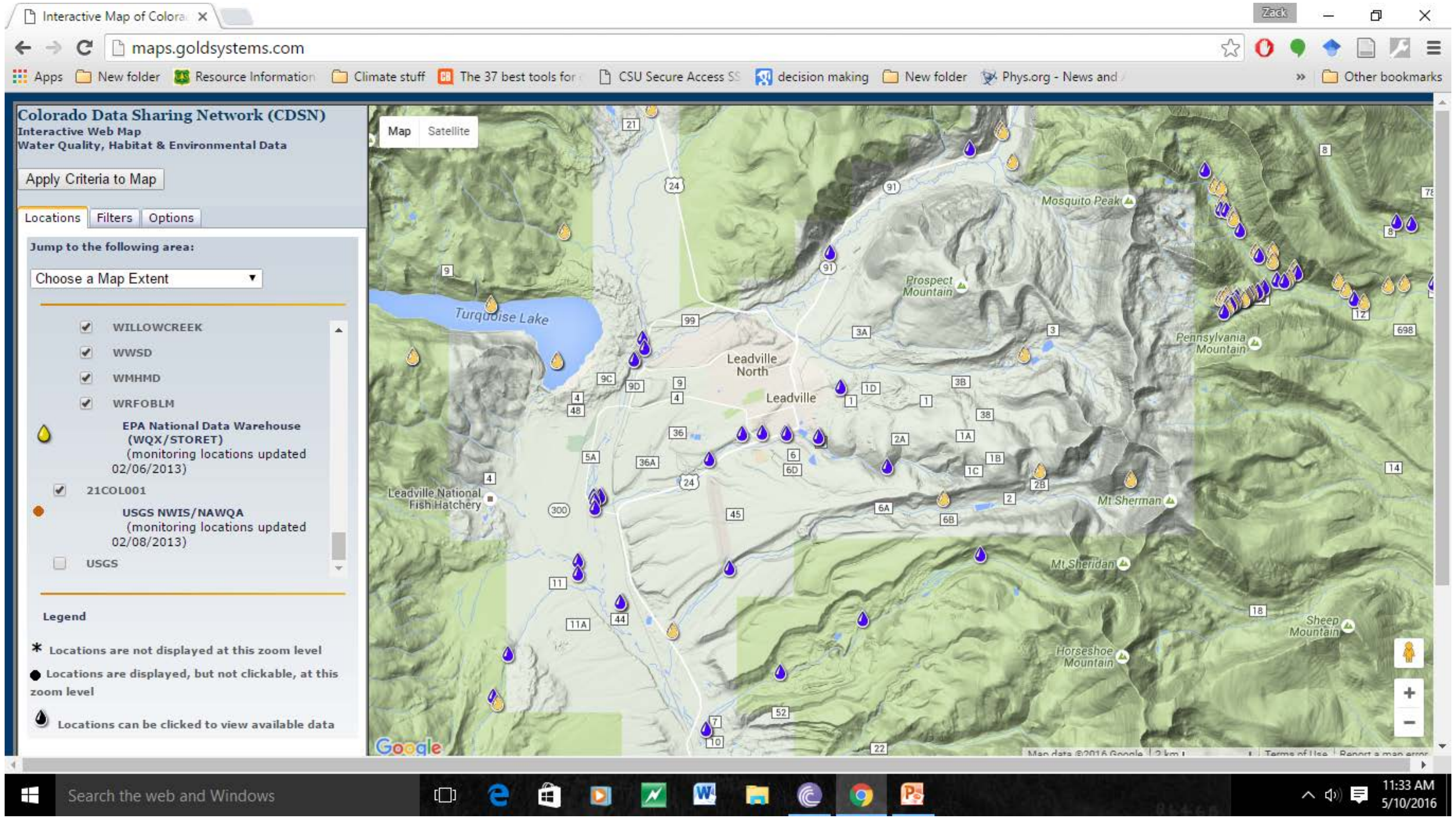
- Rapid changes in many cover types (insect/disease)
- CSE's not meant for inference above stand level; inventory rather than monitoring tool

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)



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WRFOBLM
EPA National Data Warehouse (WQX/STORET) (monitoring locations updated 02/06/2013)
21COL001
USGS NWIS/NAWQA (monitoring locations updated 02/08/2013)
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Locations are displayed, but not clickable, at this zoom level
Locations can be clicked to view available data
Map
Satellite
Turquoise Lake
Leadville North
Leadville
Leadville National Fish Hatchery
Mosquito Peak
Prospect Mountain
Pennsylvania Mountain
Mt Sherman
Mt Sheridan
Sheep Mountain
Horseshoe Mountain
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5/10/2016

Applications of the Forest Inventory and Analysis Program

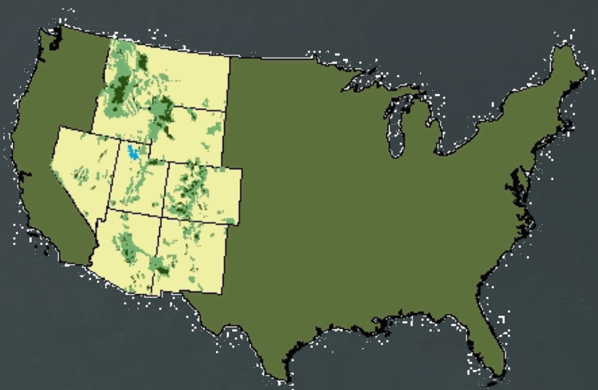
Sara A. Goeking and R. Justin DeRose

Rocky Mountain Research Station
Inventory and Monitoring Program
USDA Forest Service

Forest Inventory and Analysis

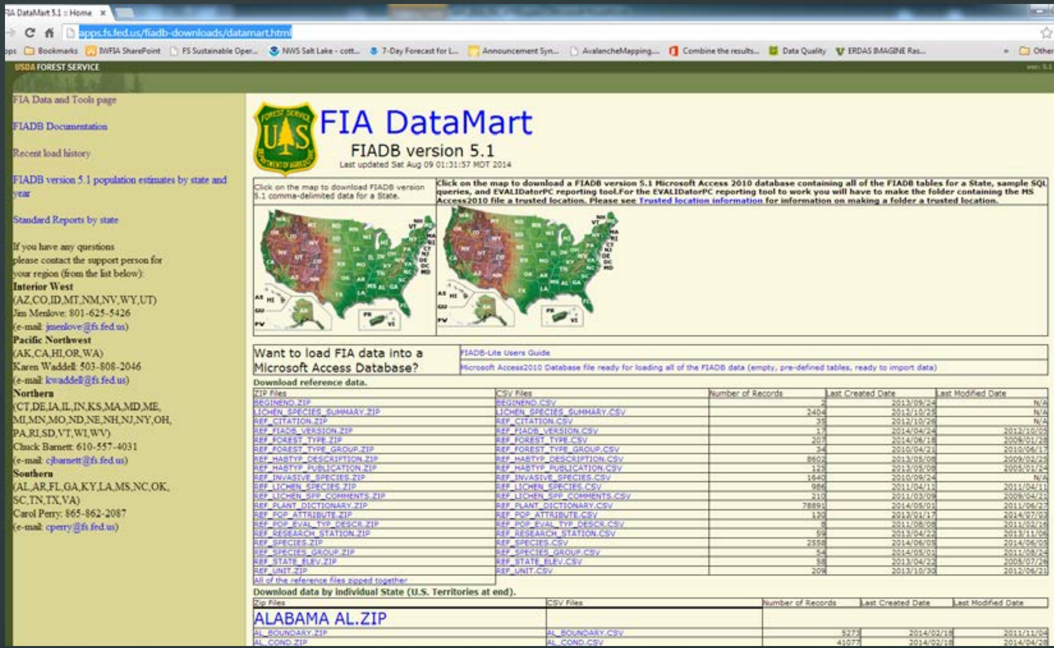
May 11, 2016
Region 2 Monitoring Workshop

Forest Inventory & Analysis (FIA) overview

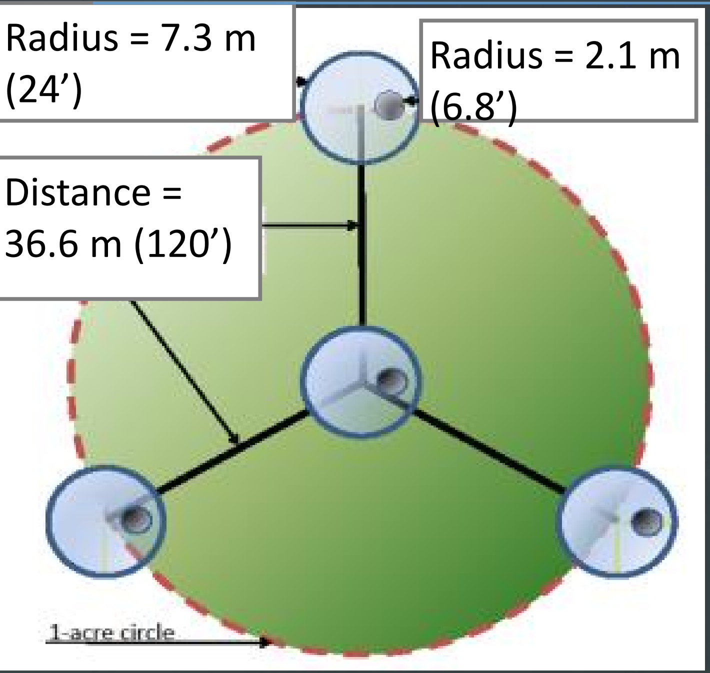


The sample:

- 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*



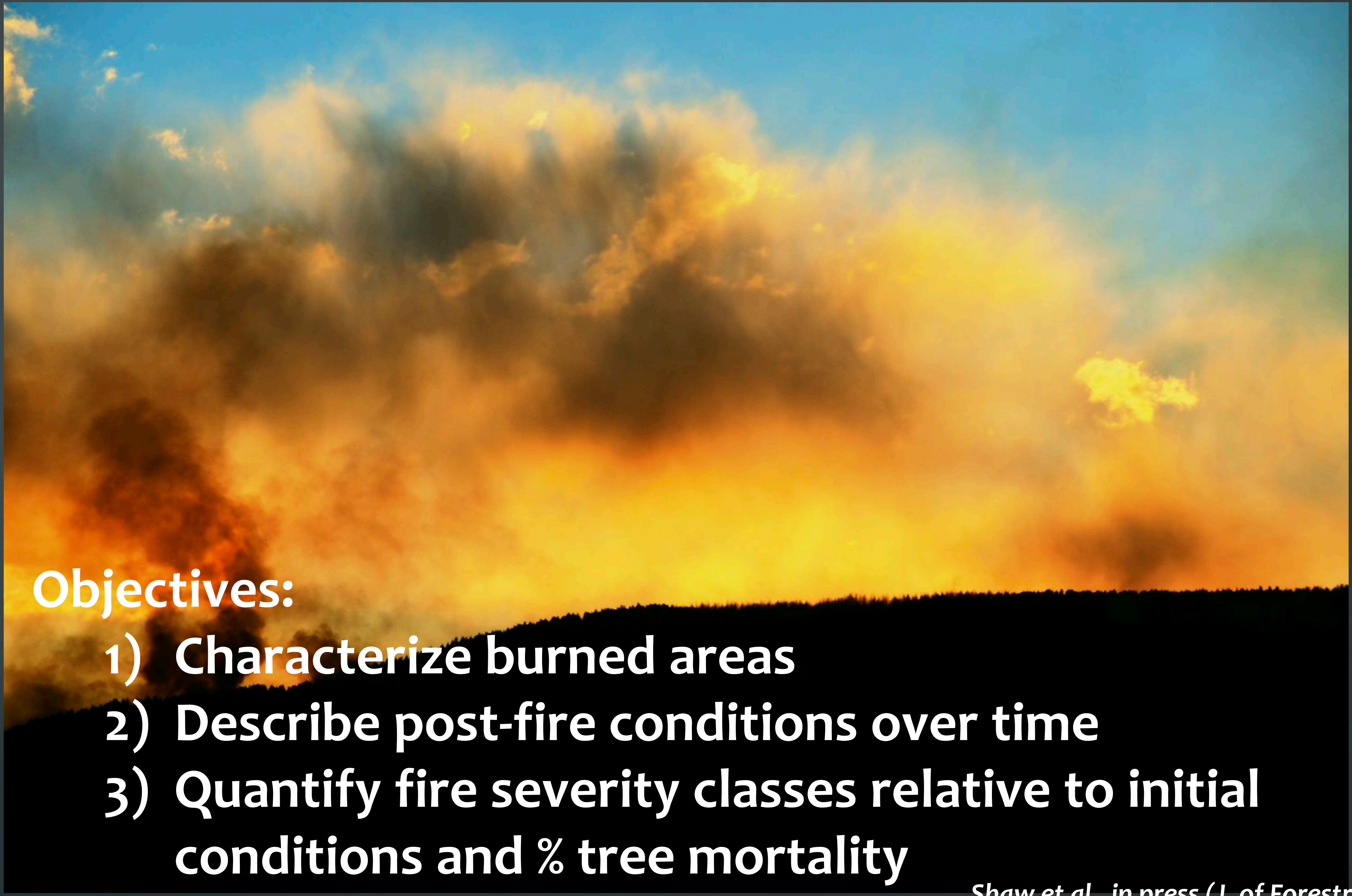
Forest Inventory & Analysis (FIA)



Types of data:

- Site and stand variables
- Large trees, saplings, and seedlings
- Understory vegetation
- Down woody debris
- Noxious weeds
- Lichens (some plots)
- Soils (some plots)

Applications of FIA data: Fire effects



Objectives:

1) Characterize burned areas
2) Describe post-fire conditions over time
3) Quantify fire severity classes relative to initial conditions and % tree mortality

Shaw et al., in press (J. of Forestry)

MTBS: Monitoring Trends in Burn Severity

- Mapping of all large fires, 1984-present
- "Large fires" are ≥ 1,000 acres (west) or 500 acres (east)
- Fire severity: low/unburned, low, moderate, and high

Available at:
MTBS.gov

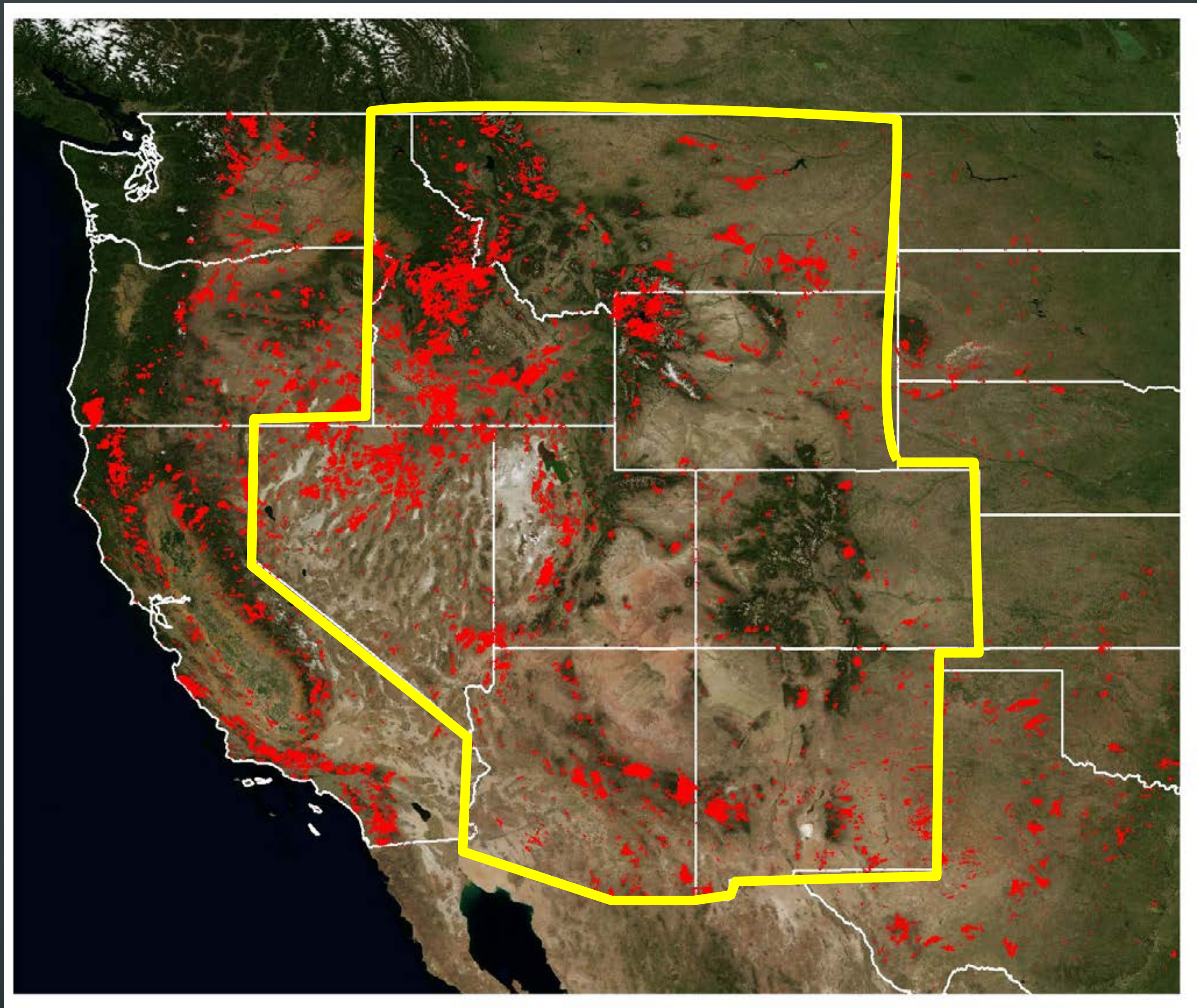
Study area: 8 Interior West states

MTBS burned-area perimeters & FIA plots

6,170 fire perimeters (1984-2012)

<u>FIA plots:</u>

- **6,372** total
- **3,219** forest
- **2,360** post-fire
- **735** pre-fire *and* post-fire

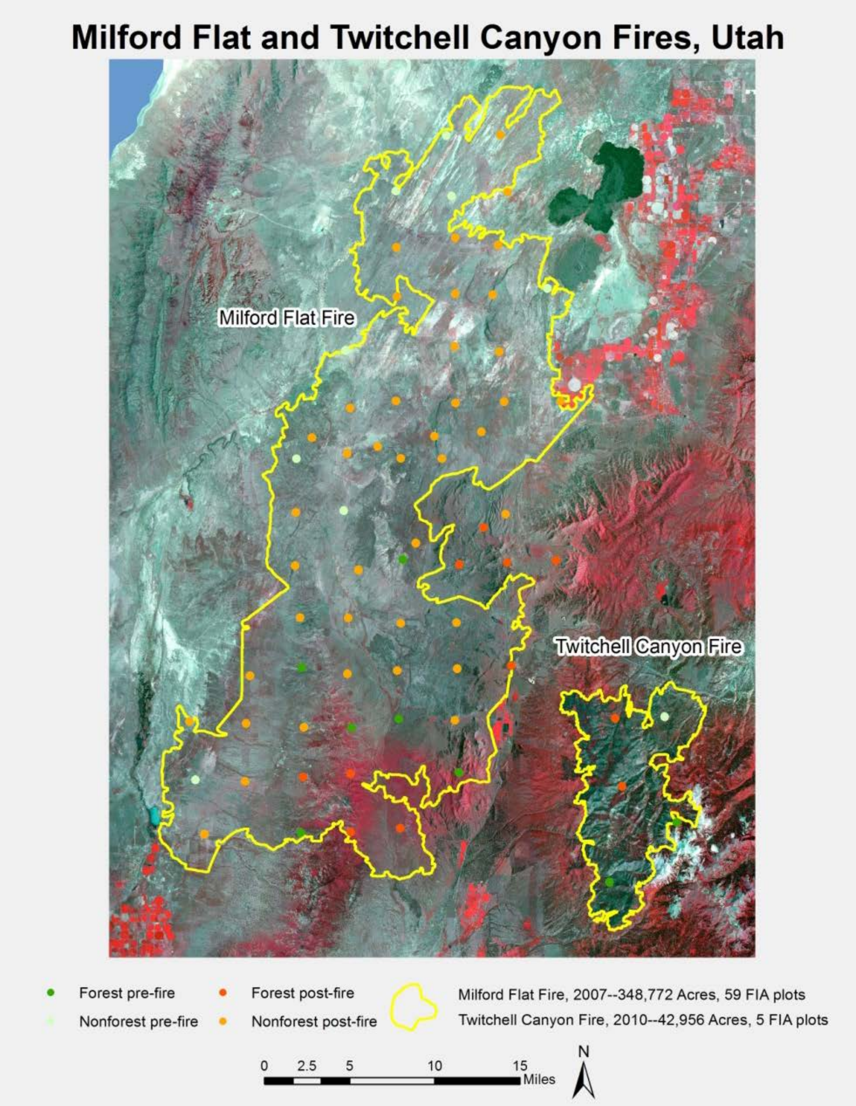


What burned: forest or nonforest?

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

The % of fires that burned forest land varied spatially, from 10% in Nevada to 65% in Montana.

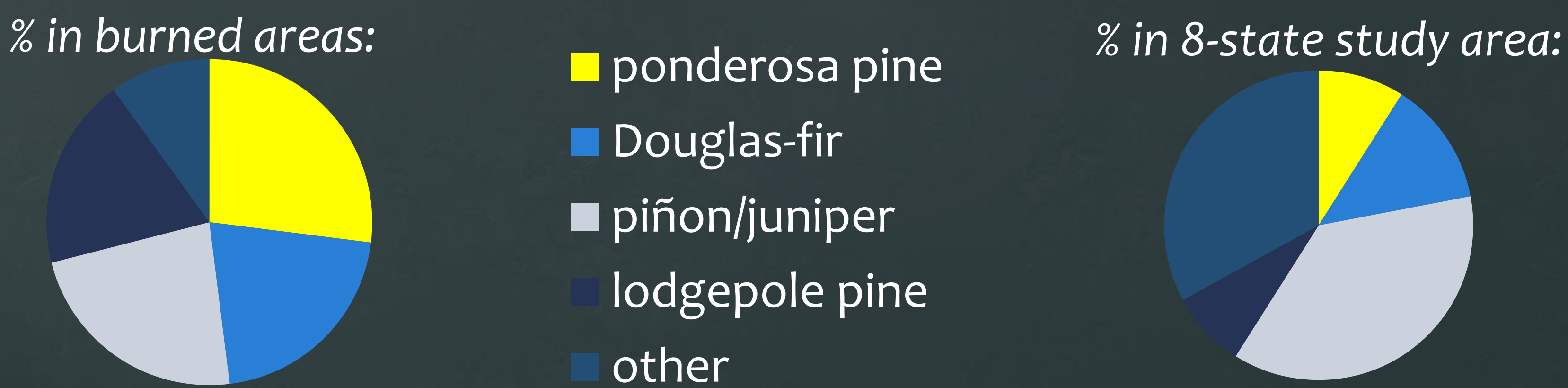
In Wyoming, large fires were 57% forest and 43% nonforest/rangeland.



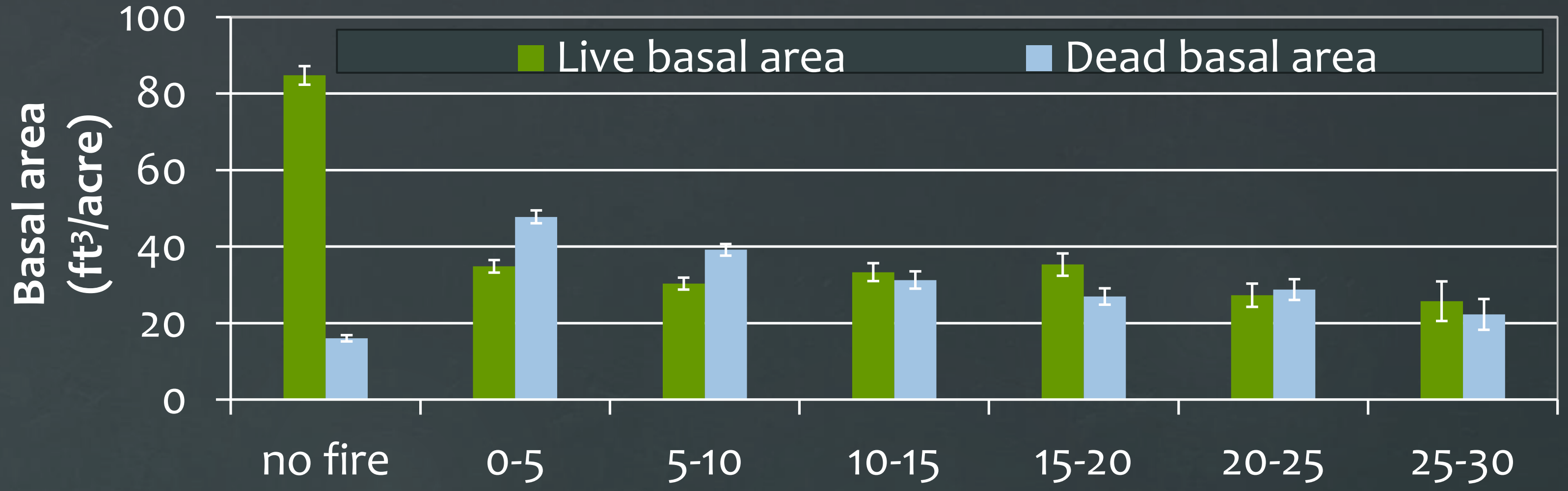
Results: Burned-area characteristics

Since 1984, large fires burned most commonly in these forest-type groups:

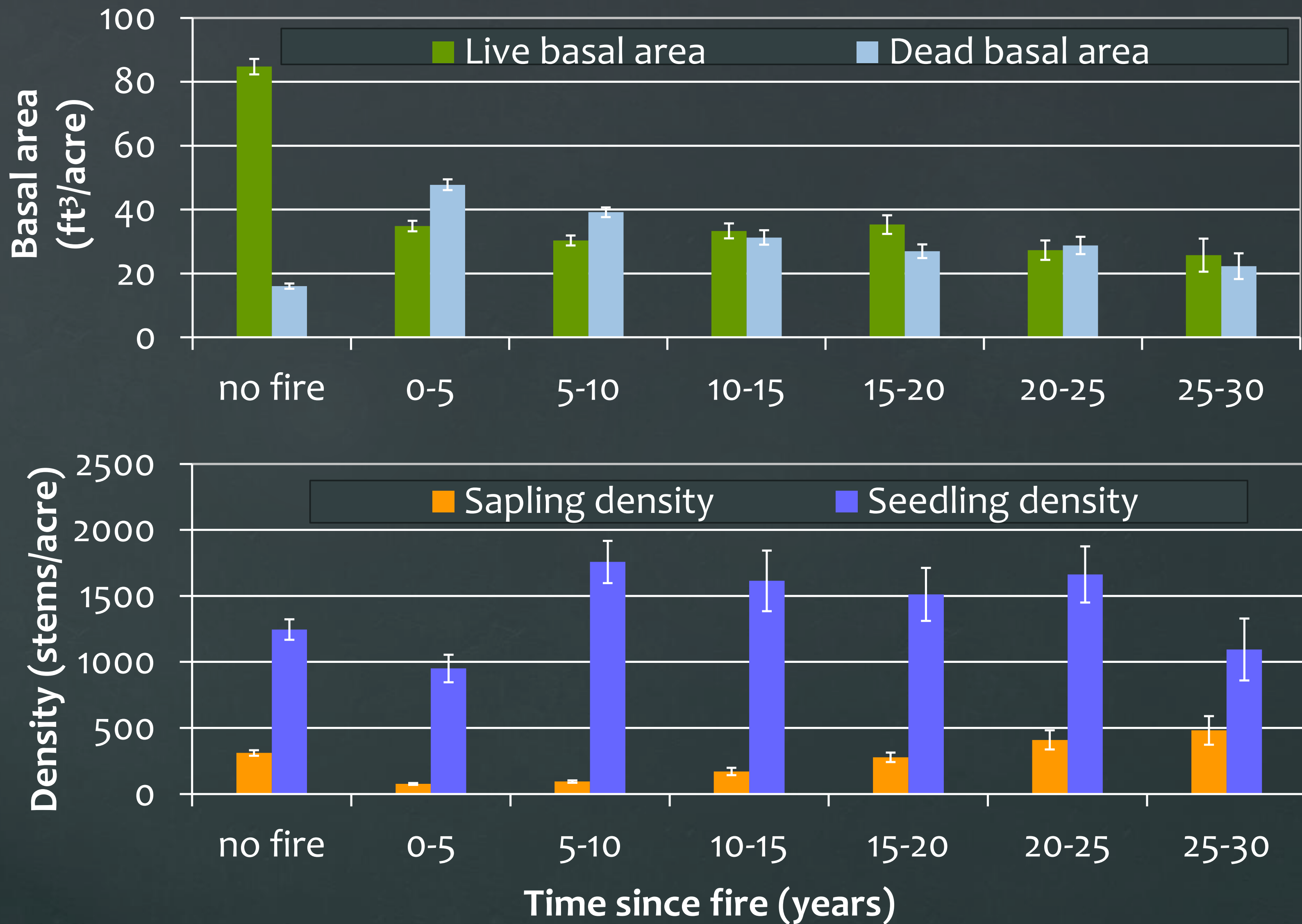
- Ponderosa pine (27%)
- Piñon/juniper (23%)
- Douglas-fir (21%)
- Lodgepole pine (19%)



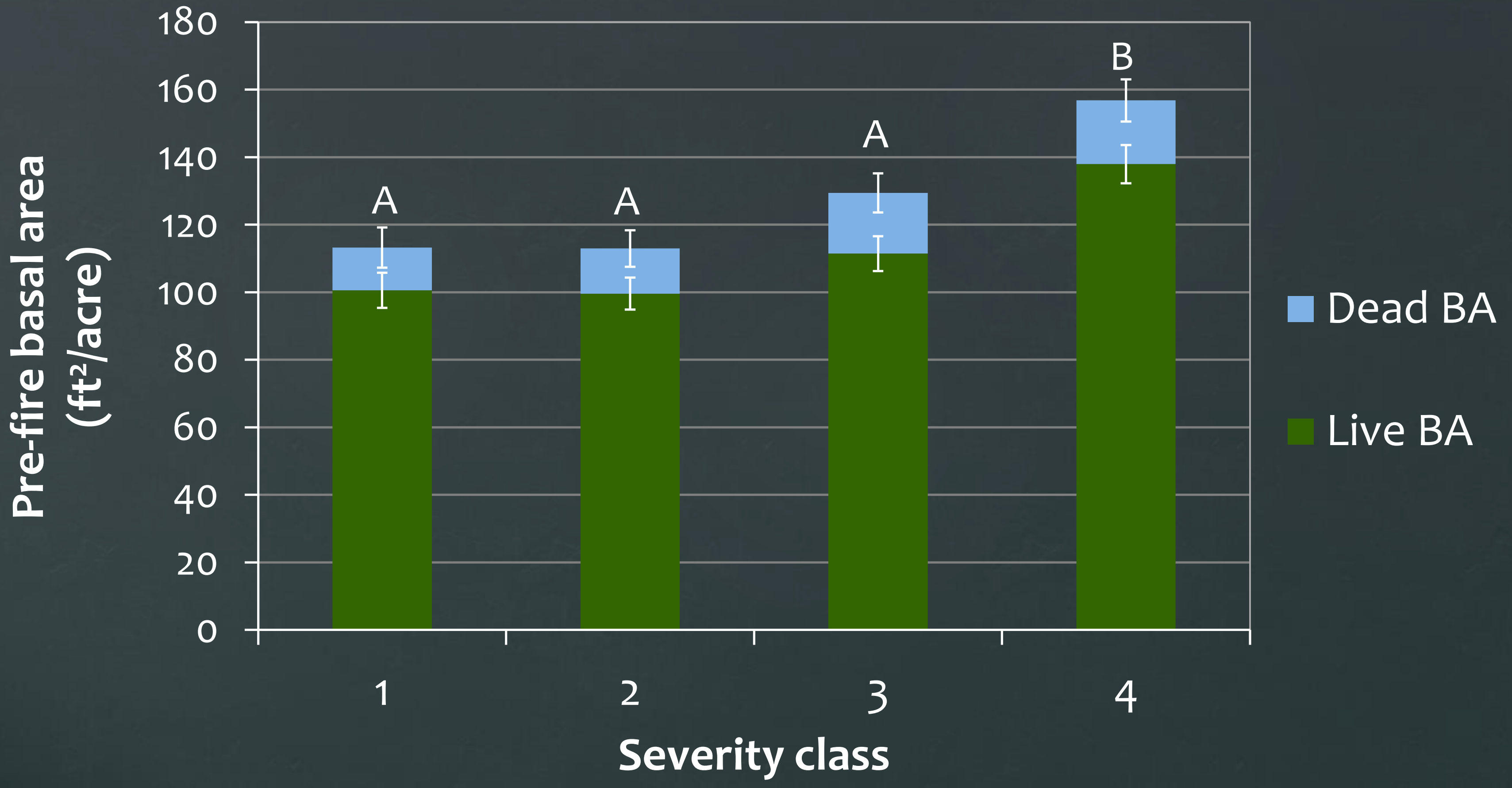
Post-fire conditions – BA and regen density



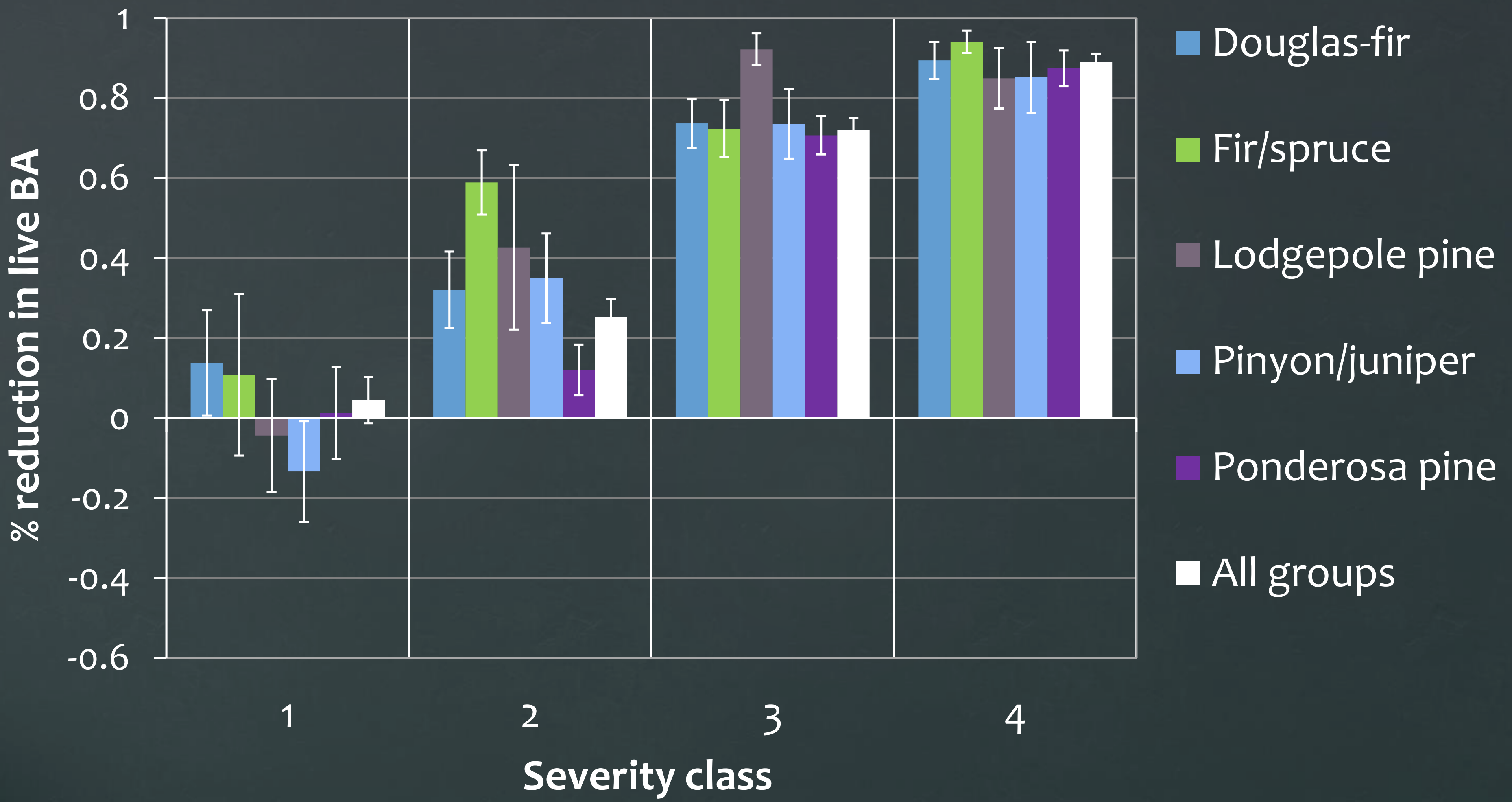
Post-fire conditions – BA and regen density



Fire severity vs. pre-fire BA



Results: Fire severity classes and % BA reduction



Applications of FIA data: Whitebark pine

Recent mortality due to insects, drought, heat, fire, and/or blister rust fungus

mountain pine beetle
(*Dendroctonus ponderosae*)

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R6–ES–2010–0047; MO 92210–0–0008]

Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List Pinus albicaulis as Endangered or Threatened With Critical Habitat

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding on a petition to list *Pinus albicaulis* (whitebark pine) as threatened or endangered and to designate critical habitat under the Endangered Species Act of 1973, as amended (Act). After review of all available scientific and commercial information, we find that listing *P. albicaulis* as threatened or endangered is warranted. However, currently listing *P. albicaulis* is precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants. Upon publication of this 12-month petition finding, we will add *P. albicaulis* to our candidate species list. We will develop a proposed rule to list *P. albicaulis* as our priorities and funding will allow. We will make any determination on critical habitat during development of the proposed listing rule. In any interim period, we will address the status of the candidate taxon through our annual Candidate Notice of Review.

DATES: The finding announced in this document was made on July 19, 2011.

blister rust fungus (*Cronartium ribicola*)

Questions *at the landscape level*:

1) Area – How much area is occupied by the various forest types with a WBP component?

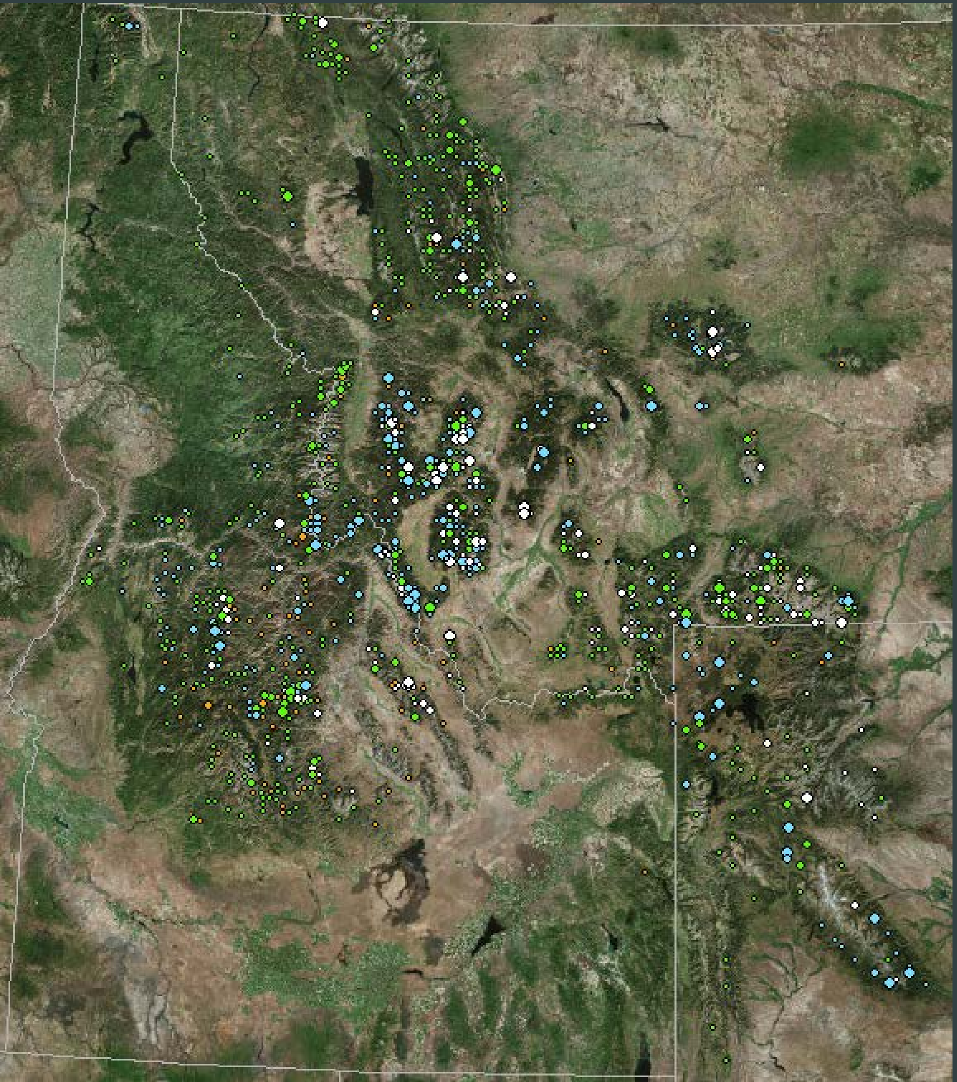
2) Regeneration – What are typical seedling densities, and where?

3) Size class distribution – Is the size class distribution of WBP in other forest types similar to that in pure WBP stands?

4) Growth and mortality of WBP – Are rates similar among all forest types?

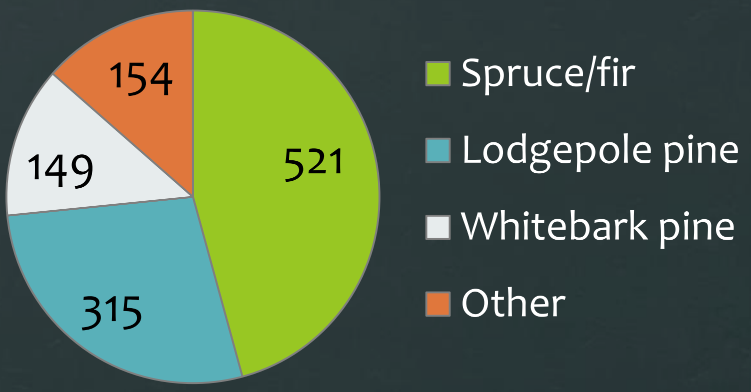
WBP mortality due to fire,
Frank Church Wilderness, Idaho

FIA plots with whitebark pine in the northern Rockies

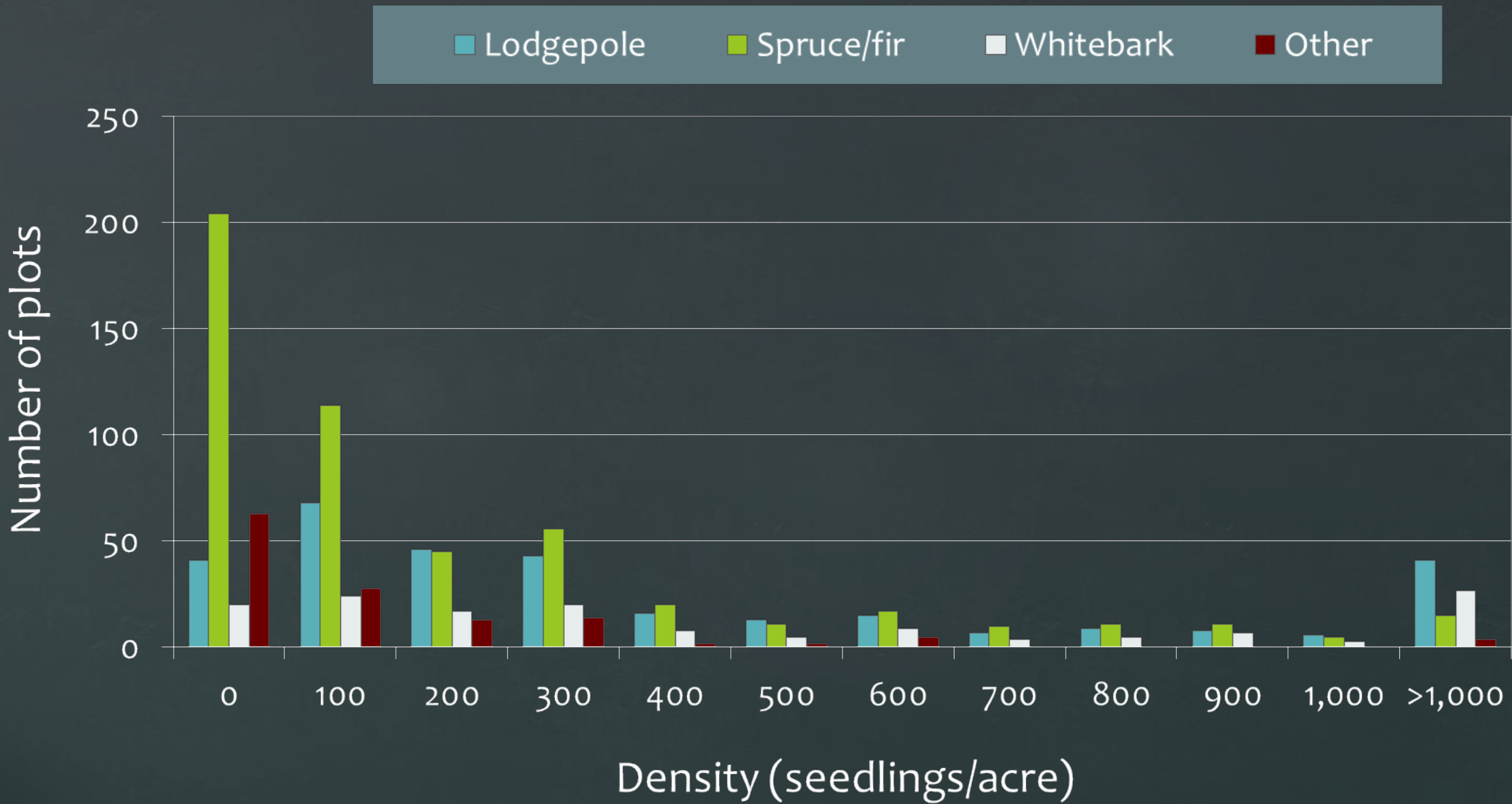


In the U.S. Northern Rocky Mountains,
1,139 plots
have a whitebark pine component

Number of plots, by forest type

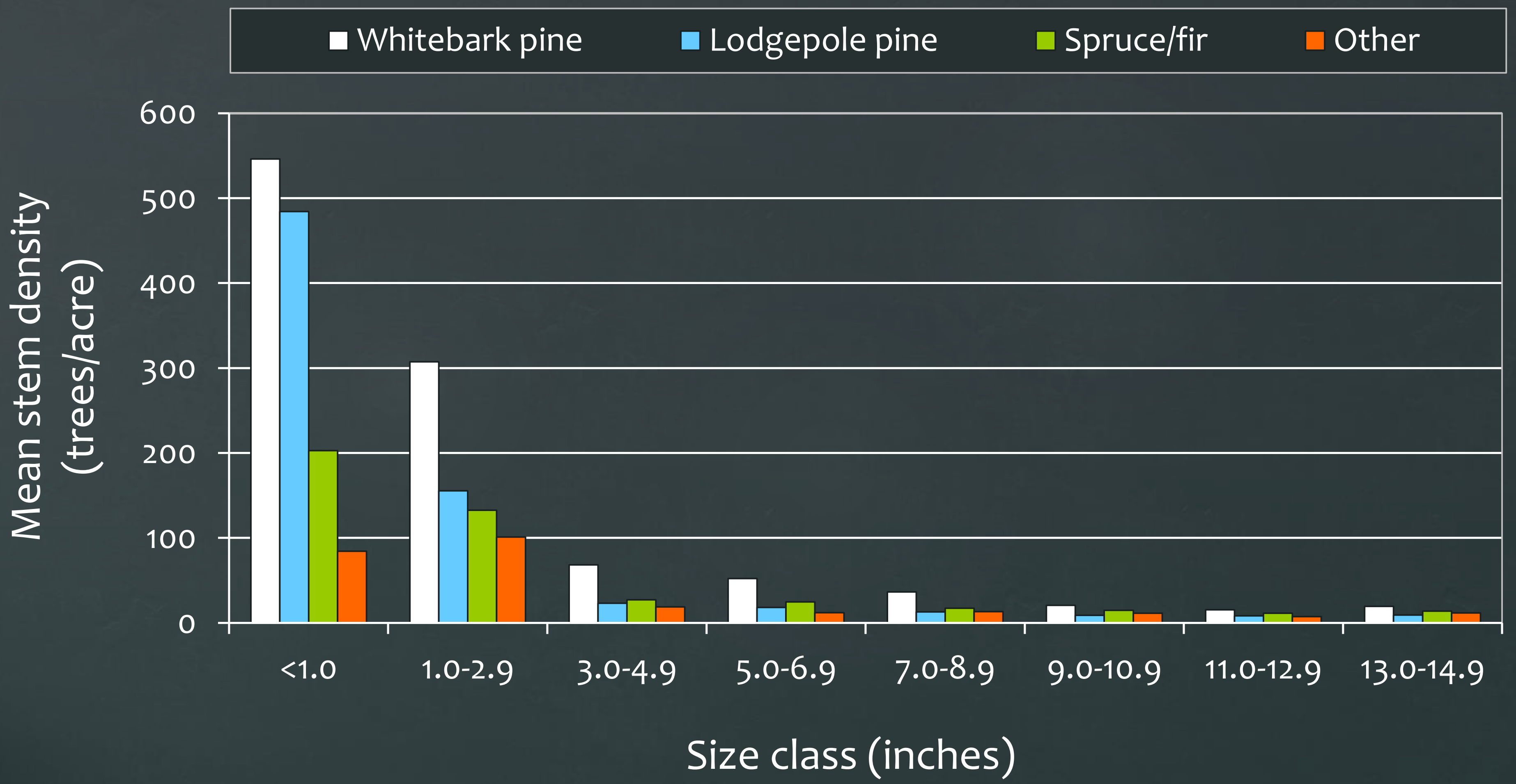


Seedling density by forest type

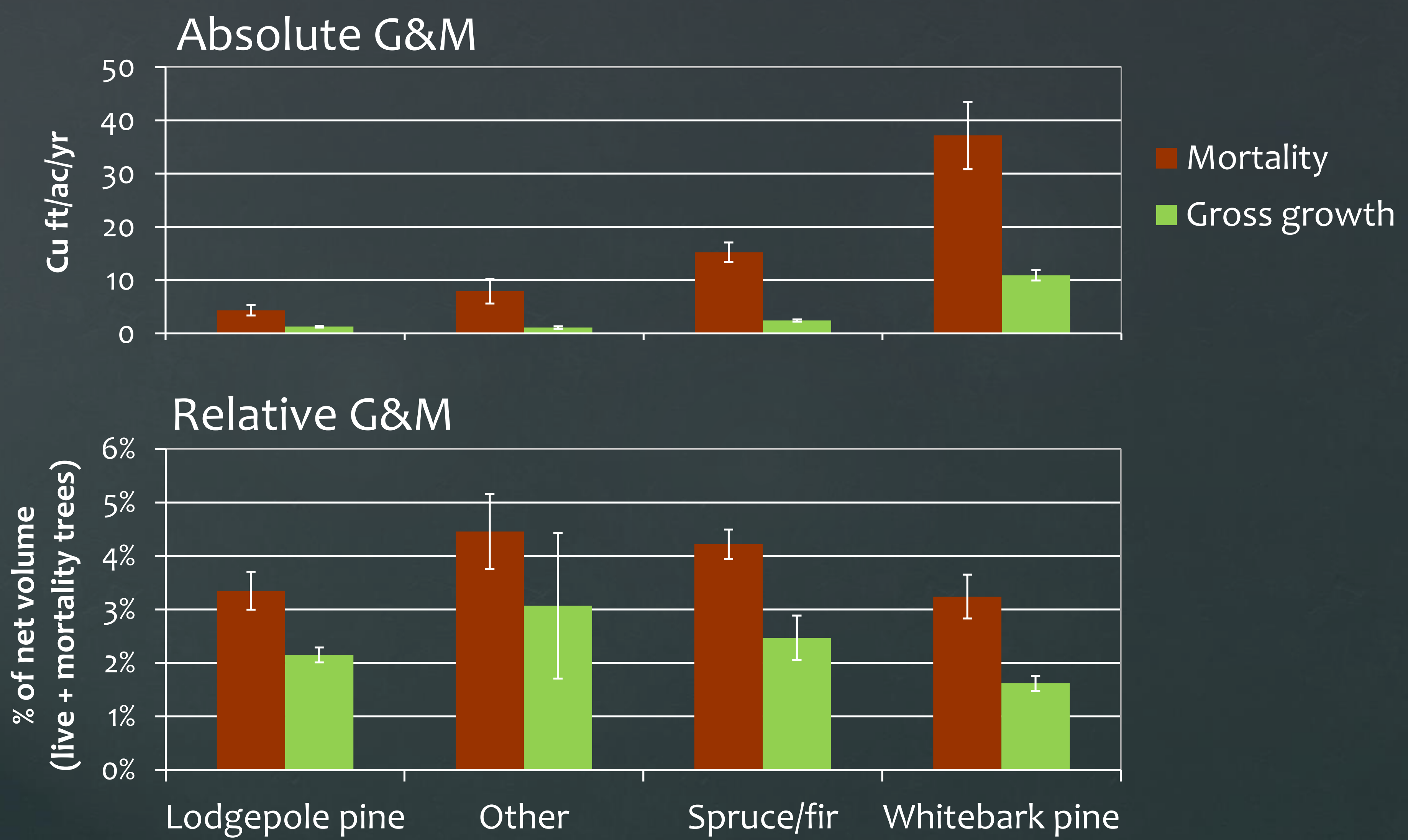


Max: 6,000+ seedlings per acre (15,000+ per hectare)
Mean : 321 seedlings/ac (793 seedlings/ha)
Median: 100 seedlings/ac (247 seedlings/ha)

Size class distribution

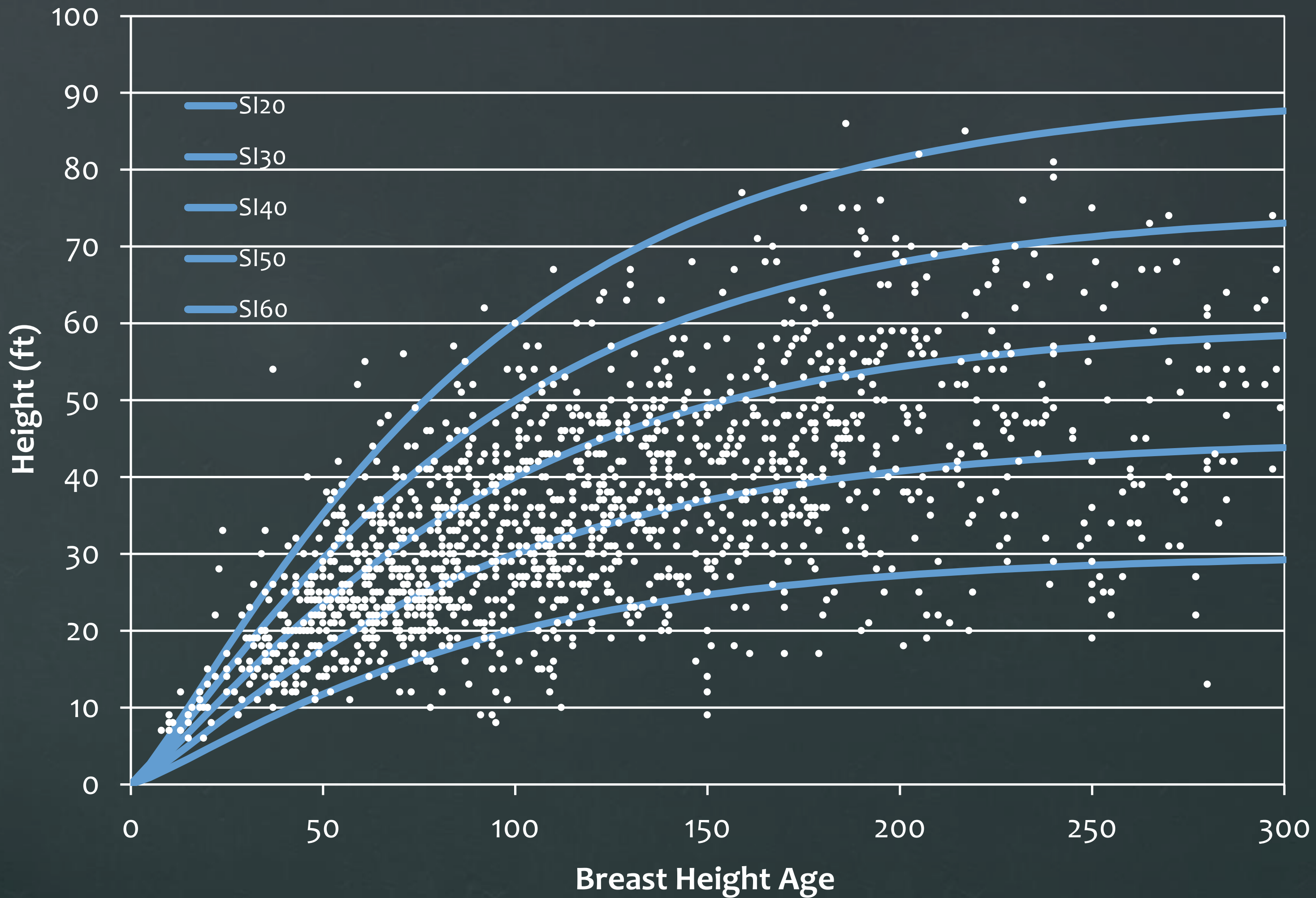


Mean mortality and growth, by forest type



Site Index Curves for Whitebark Pine

$$Height = SI\left(\frac{1 - \exp(b * AGE)}{1 - \exp(b * 100)}\right)^{c}$$



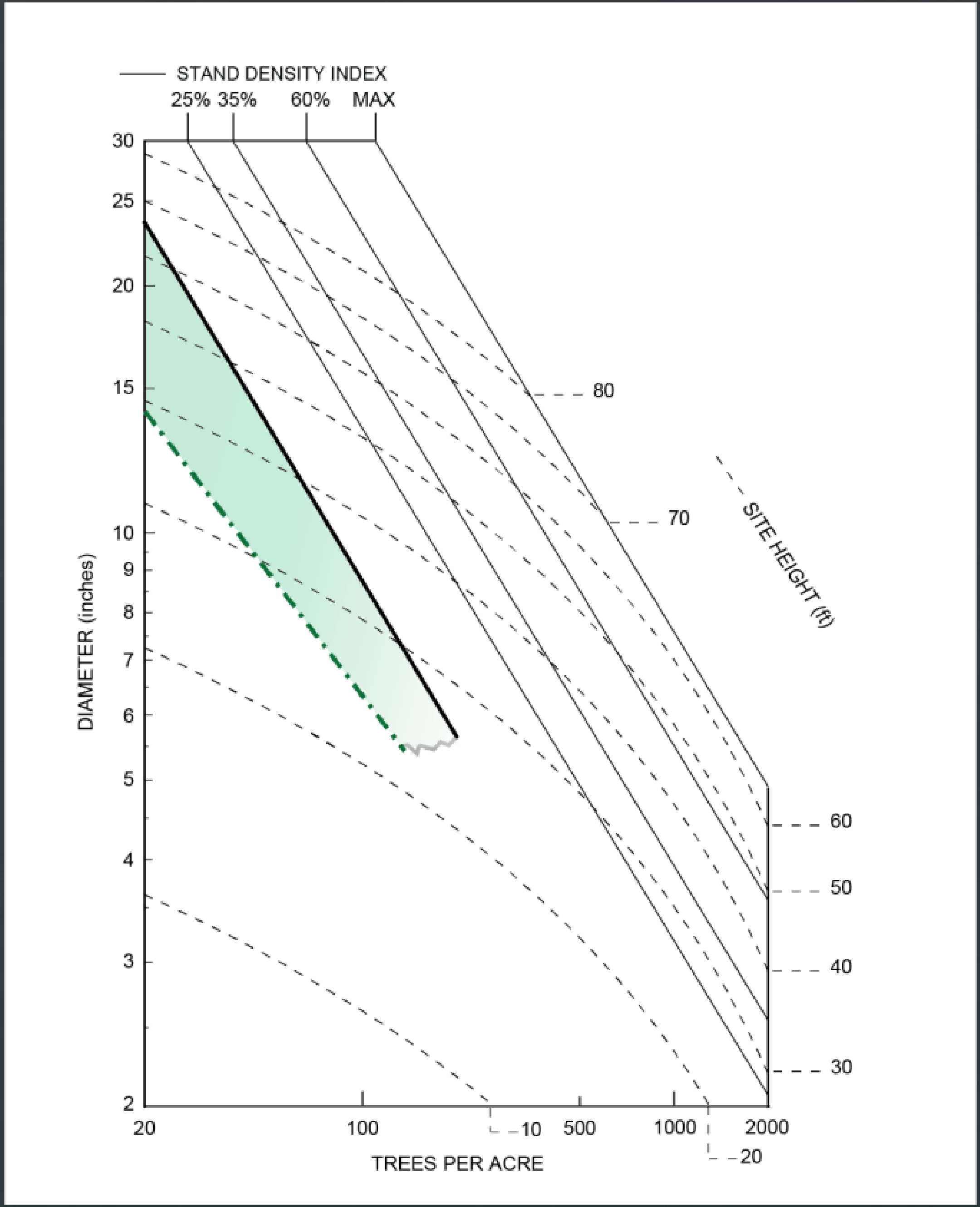
Density Management Diagram for Whitebark Pine

SDI >= 80

WBP is more susceptible to MPB (Perkins & Roberts 2003)

Stocking required by Clark's nutcrackers (McKinney et al. 2009)

From Long and Shaw (In rev.) WJAF



FIA applications:

Wildlife habitat assessment and monitoring

Off-grid plot measurements

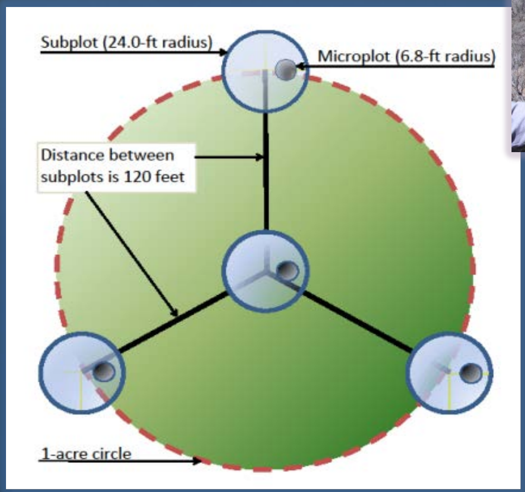
- Establish a full or partial plot inventory off the standard FIA grid at a site based on importance/use by the species of interest.
- Data can be related back to standard FIA data to identify all plots that meet habitat criteria and thus provide area estimates of preferred habitat in a geographic area of interest.

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

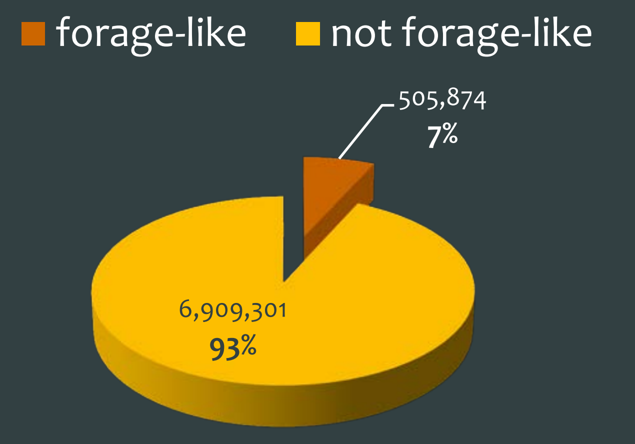
Methods

1) Capture birds and attach radio transmitters

2) GBBO and NPS staff locate and observe birds/ mark cache sites



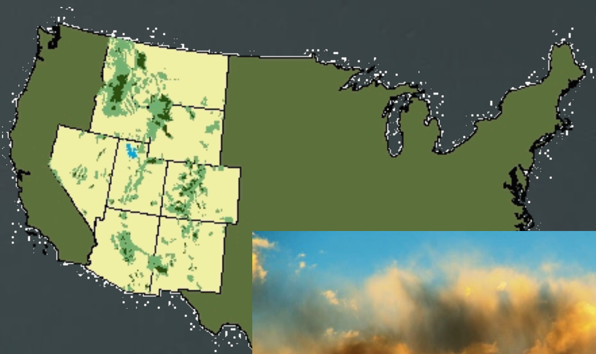
3) FIA crews establish plot at cache site



4) Estimate habitat area

What are FIA data good for?

- ✓ Broad-scale assessment of pattern and trend in forest attributes
- ✓ Quantifying the effects of disturbances (or current issues of interest)
- ✓ Assessment of tree species of interest
- ✓ Assessment and monitoring of wildlife habitat



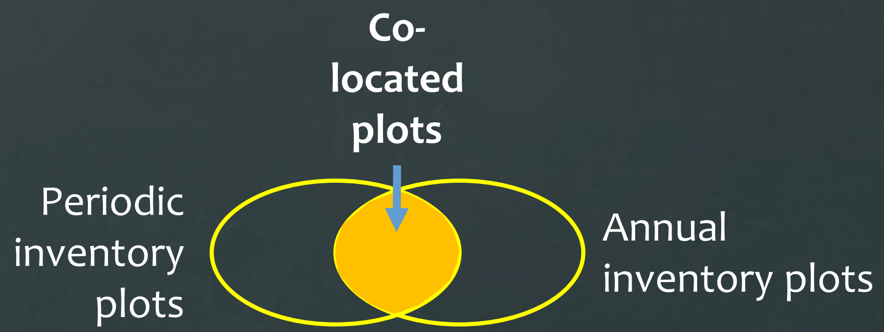
- X Project-level planning
- X Small-scale analysis (without intensification)

History of FIA in Wyoming

Periodic inventories used different sample designs and were biased toward certain ownership groups and forest types:

- Early 1980s
- Early 1990s
- 1998-2002 (more comprehensive, and using current plot design)

Annual inventory began in 2011. Plots are measured every year, with the same plots measured every 10 years.

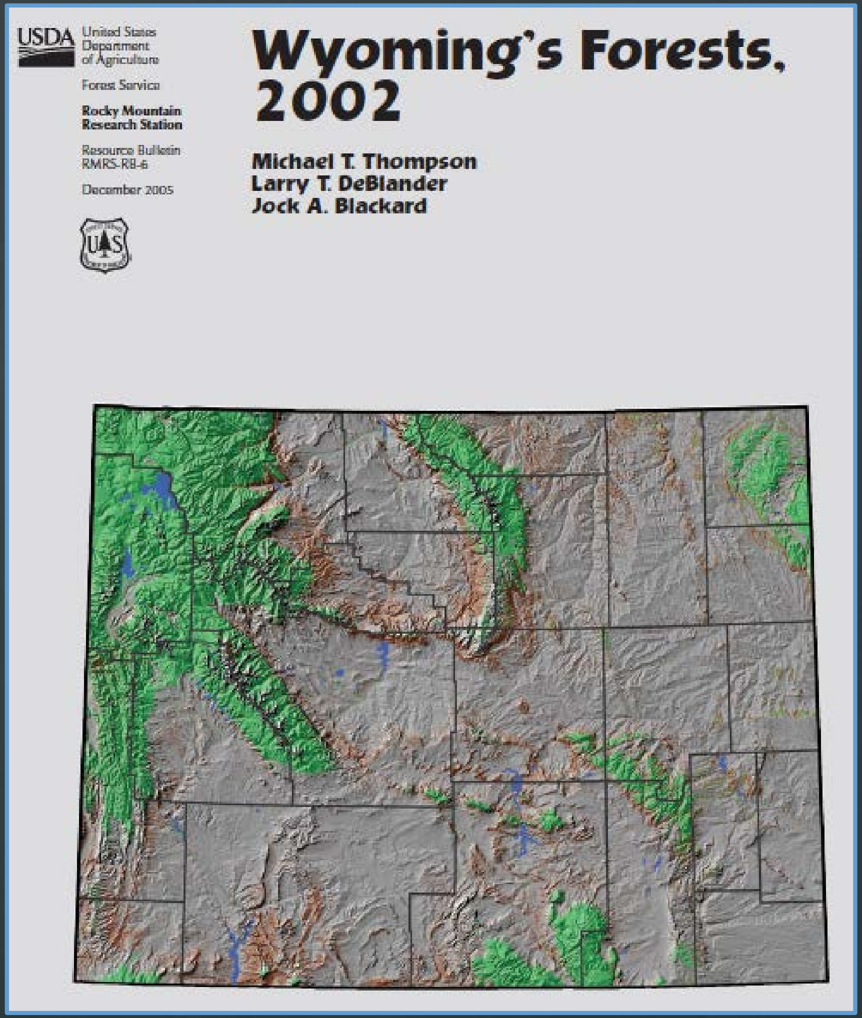


How can we assess trends?

- ✓ Both periodic and annual inventories allow estimation of forest attributes per unit area.
- ✓ Some plots were measured during both inventories = **co-located plots.**

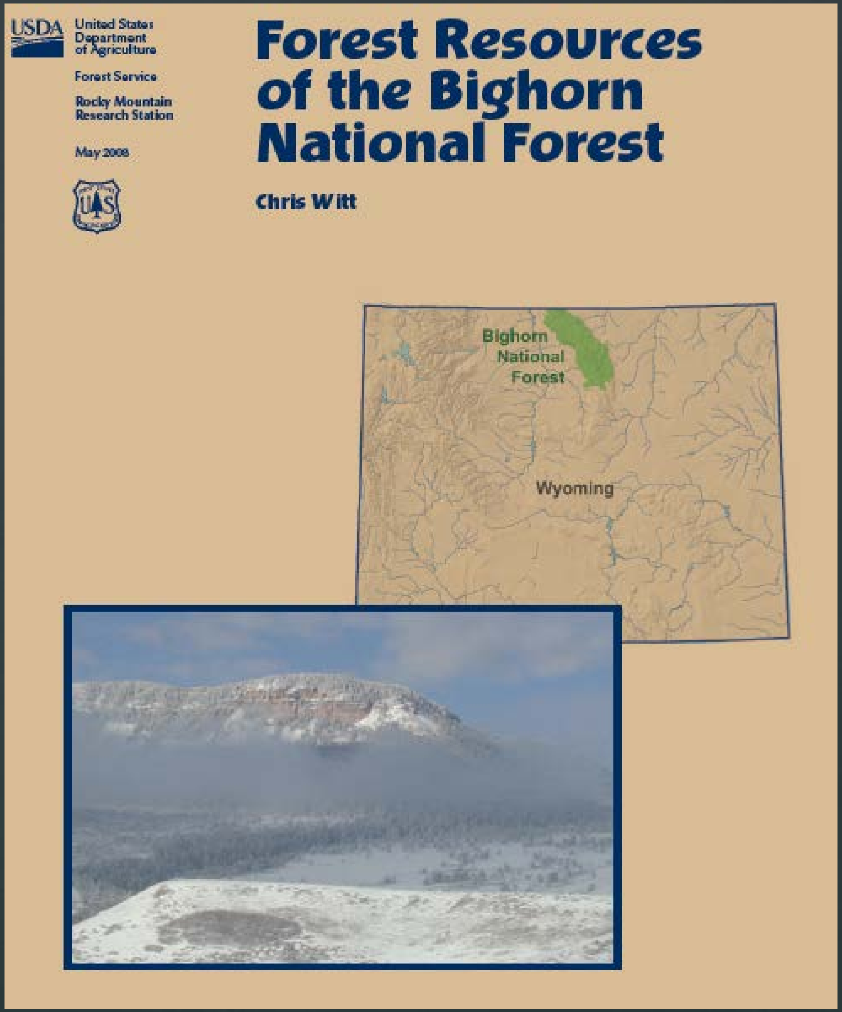
Wyoming's Forests 2002

Based on the periodic data 1998-2002.



What’s next for FIA in Wyoming?

We can produce custom analyses by Forest, BLM district, state district, etc., or look at species or issues of interest – ***just call us!***



What's next for FIA in Wyoming?

The first statewide FIA report on Wyoming's forest resources in more than 10 years, and ***we want your input!***

- ✓ Inventory Results for Forest Land
  - ✓ Area
    - ✓ Forest type
    - ✓ Stand-size
    - ✓ Stand age
    - ✓ Basal area classes
    - ✓ Stand density index
  - ✓ Number of trees
  - ✓ Biomass and Volume
  - ✓ Growth and Mortality
  - ✓ Removals for Timber Products

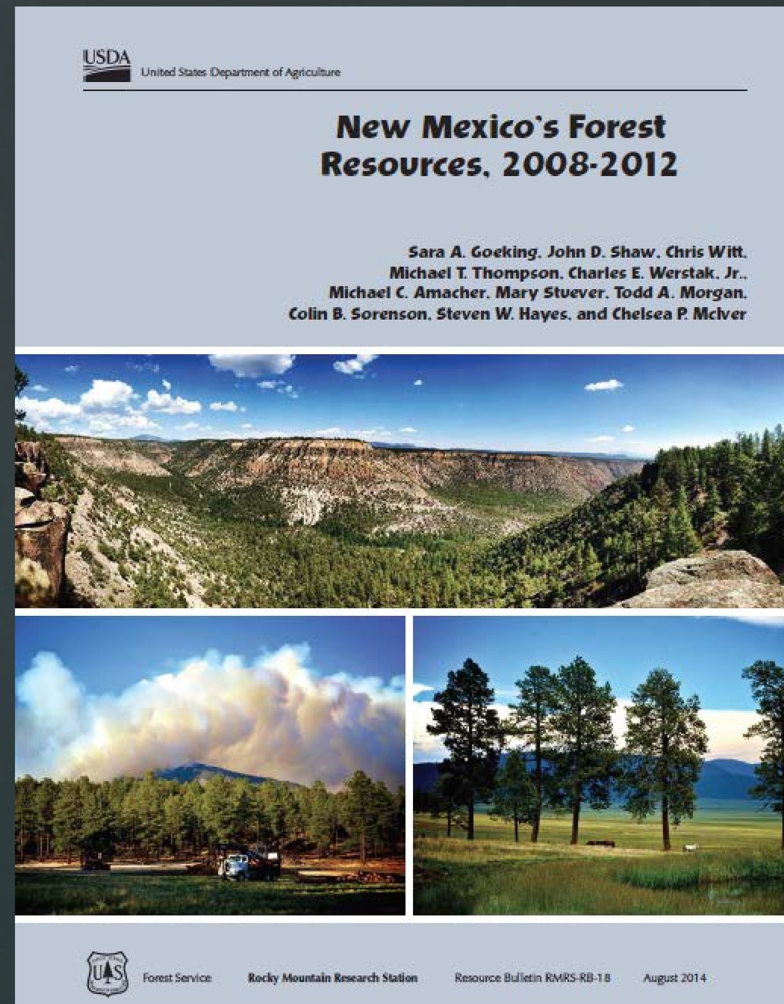
- ✓ Yellowstone National Park

What's next for FIA in Wyoming?

The most recent New Mexico Report includes:

- ✓ Overview of New Mexico's Forests
  - ✓ Area
    - ✓ Forest type
    - ✓ Stand-size
    - ✓ Stand age
    - ✓ Basal area classes
    - ✓ Stand density index
  - ✓ Number of trees
  - ✓ Biomass and Volume
  - ✓ Growth and Mortality
  - ✓ Removals for Timber Products

~~✓ Yellowstone National Park~~



What's next for FIA in Wyoming?

The New Mexico Report also includes:

- ✓ New Mexico's Forest Resources
  - ✓ Timber harvest
  - ✓ Traditional forest uses
  - ✓ Wildlife habitat
  - ✓ Old forests
  - ✓ Understory vegetation
  - ✓ Down woody material
  - ✓ Forest soils
- ✓ Current Issues…
  - ✓ Drought-related mortality
  - ✓ Aspen status/trends
  - ✓ Damage to live trees
  - ✓ Invasive and noxious weeds
  - ✓ Riparian forests

What's next for FIA in Wyoming?

Wyoming's Forests 2011-2015:

- ✓ Wyoming's Forest Resources:
  - ✓ Timber harvest
  - ✓ Wildlife habitat
  - ✓ Down woody material (ie, fuels)
  - ✓ …

- ✓ Current Issues in Wyoming Forests
  - ✓ Wildfire effects
  - ✓ Insect Infestation effects
  - ✓ Invasive and noxious weeds
  - ✓ Aspen forests
  - ✓ Water resources
  - ✓ …

Questions?
Forest Inventory and Analysis
Rocky Mountain Research Station
Contacts:
Sara Goeking
sgoeking@fs.fed.us
Justin DeRose
rjderose@fs.fed.us

Broader-Scale Monitoring Strategy Workshop Laramie, Wyoming
11 May 2016

Data Management, Analysis, and Applications

Gary P. Beauvais, Director – Wyoming Natural Diversity Database

11 May 2016

WYNDD
Wyoming Natural Diversity Database

A service and research unit of the University of Wyoming dedicated to collection, interpretation, and dissemination of scientific information on the rare species and vegetation of Wyoming

MAIN IDEAS :

1. An apparent gap between science and management

2. Important differences between ***data*** and ***information***

3. Benefits to centralizing natural resource data (and some information products, too)


Scientists
Resource managers

Data is not information… or knowledge… etc.

KNOWLEDGE, WISDOM… …

Policy, culture, etc.

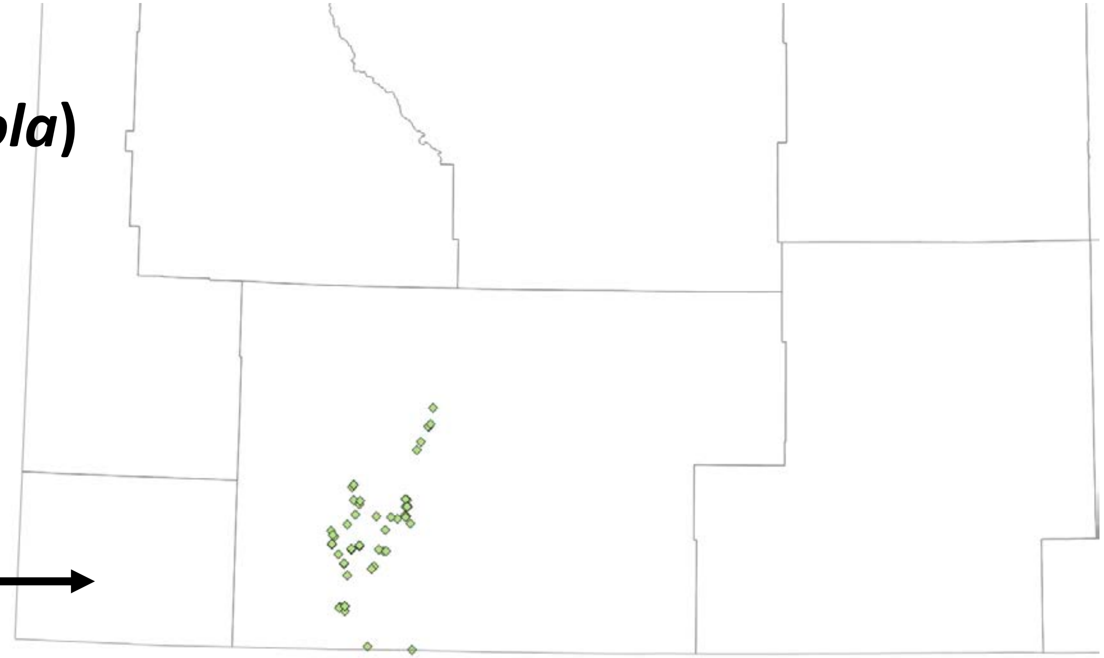
INFORMATION – range maps; predicted distributions; habitat maps; population trend estimates

Modeling, analysis

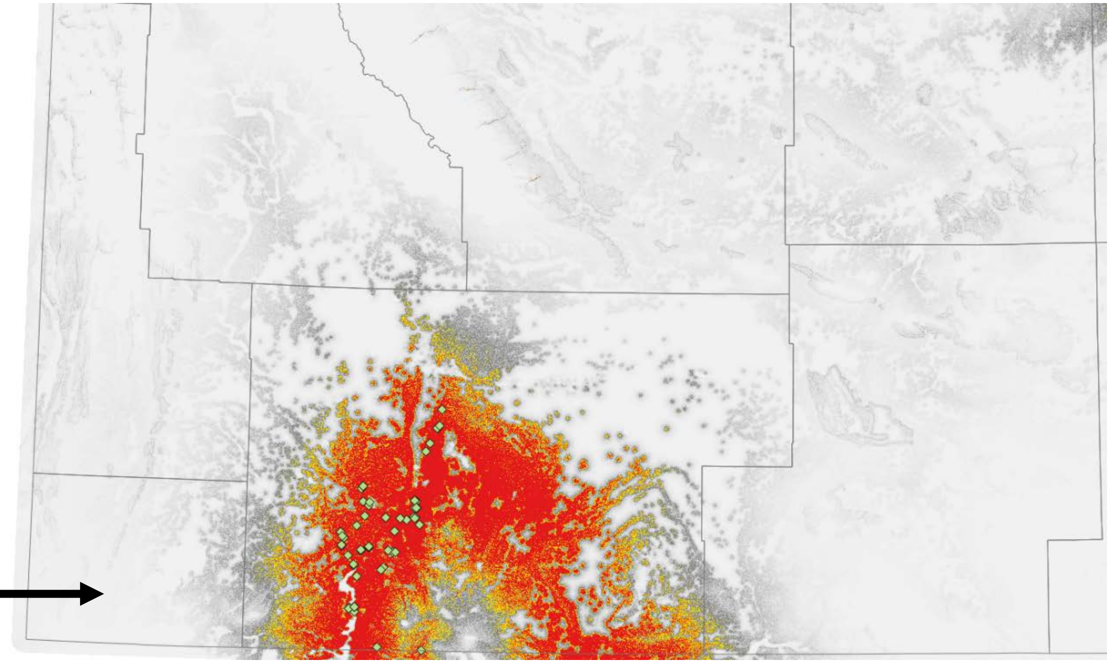
DATA – species observation points; habitat msrmts

Great Basin Gophersnake (*Pituophis catenifer deserticola*)

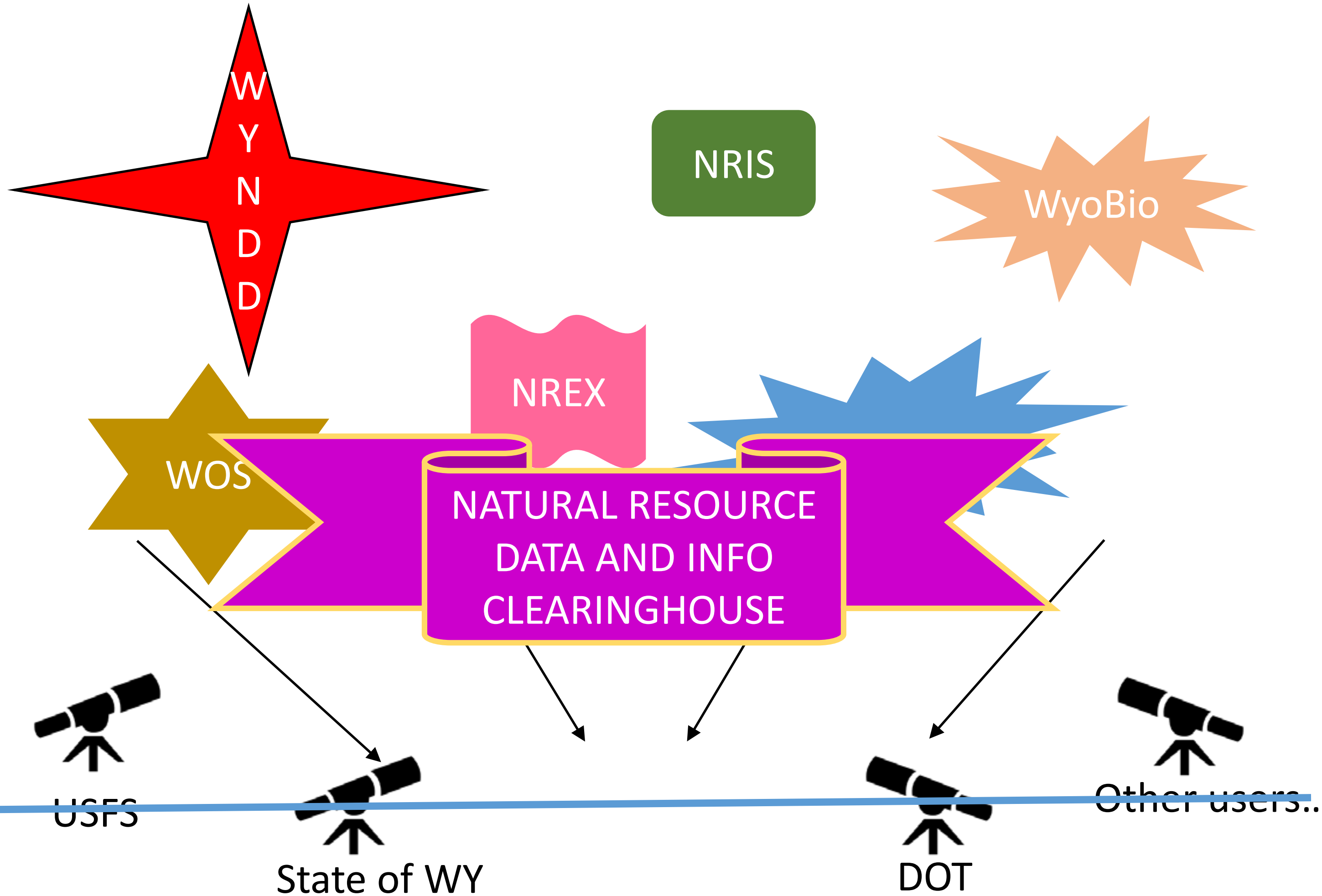
Points of known occurrence in Wyoming (data)



Predicted distribution in Wyoming (information)



NOW :


WYNDD
NRIS
WyoBio
NREX
WOS
NATURAL RESOURCE DATA AND INFO CLEARINGHOUSE
USFS
State of WY
DOT
Other users…

SOON :

MAIN IDEAS :

1. **An apparent gap between science and management**

   How can we make good science more readily <u>available</u> to managers and project operators?

2. **Important differences between *<u>data</u>* and *<u>information</u>***

   How can we communicate the limitations of basic data, as well as modeled information products?

3. **Benefits to centralizing natural resource data and information**

   Too many disparate, competing datasets is almost as bad as too few datasets

WYOMING POCKET GOPHER (*Thomomys clusius*)

1974: Species first described

1976: 22 total observation records

2006: WYNDD produces first distribution model

2006: WYNDD publishes full species assessment

2007: WYNDD begins field surveys; trains others in survey methods

2007: Petitioned for ESA listing

2008: WYNDD updates distribution model

2008: 34 observation records at WYNDD

2010: USFWS decides listing not warranted

2013: WYNDD updates distribution model

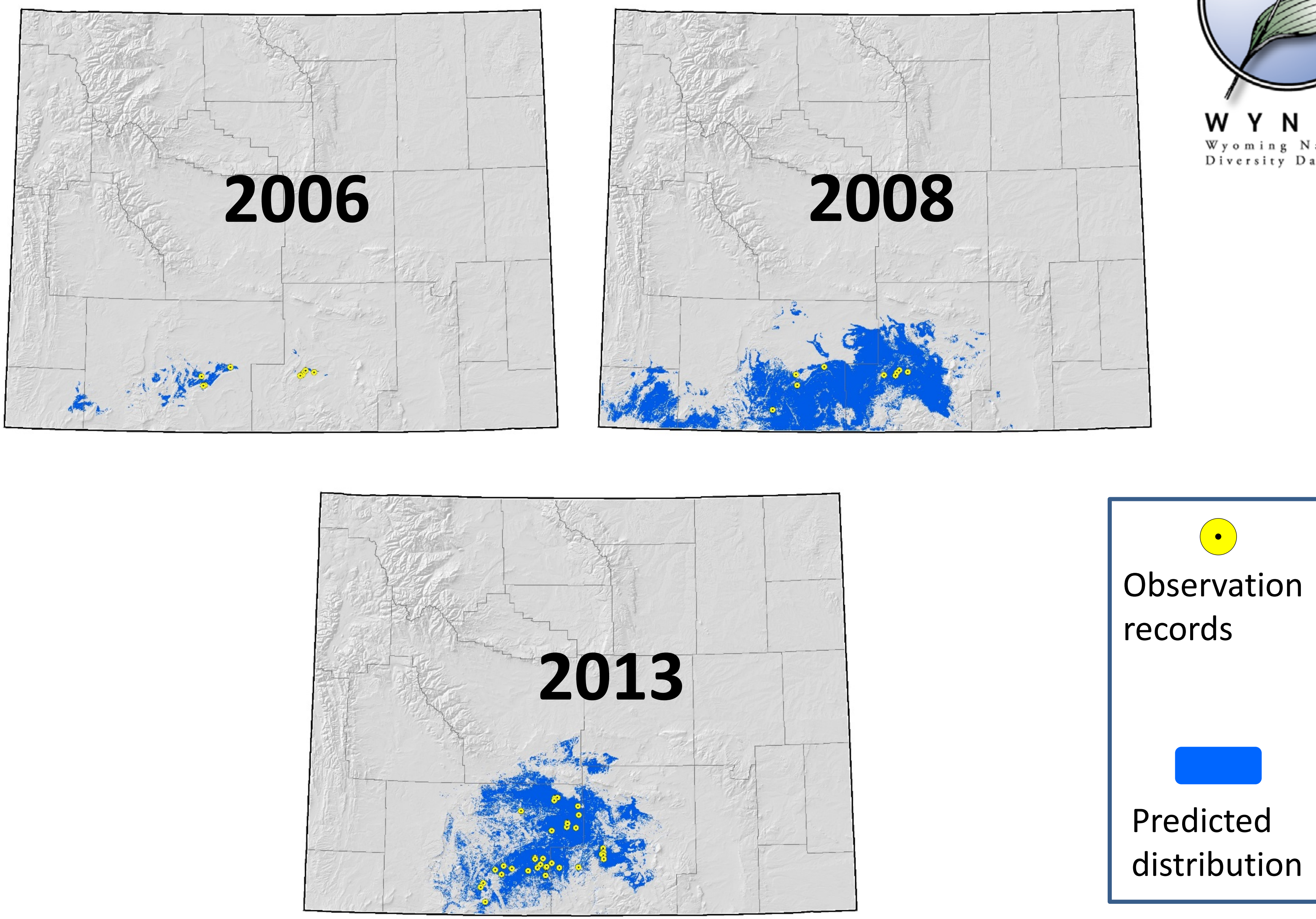
2013: 70 observation records at WYNDD

April 2016: Re-petitioned for ESA listing

WYOMING POCKET GOPHER (*Thomomys clusius*)

Predicted distribution in Wyoming

WYNDD
Wyoming Natural Diversity Database



WYOMING POCKET GOPHER (*Thomomys clusius*)
Predicted distribution in Wyoming, circa **2014**

WYNDD
Wyoming Natural Diversity Database

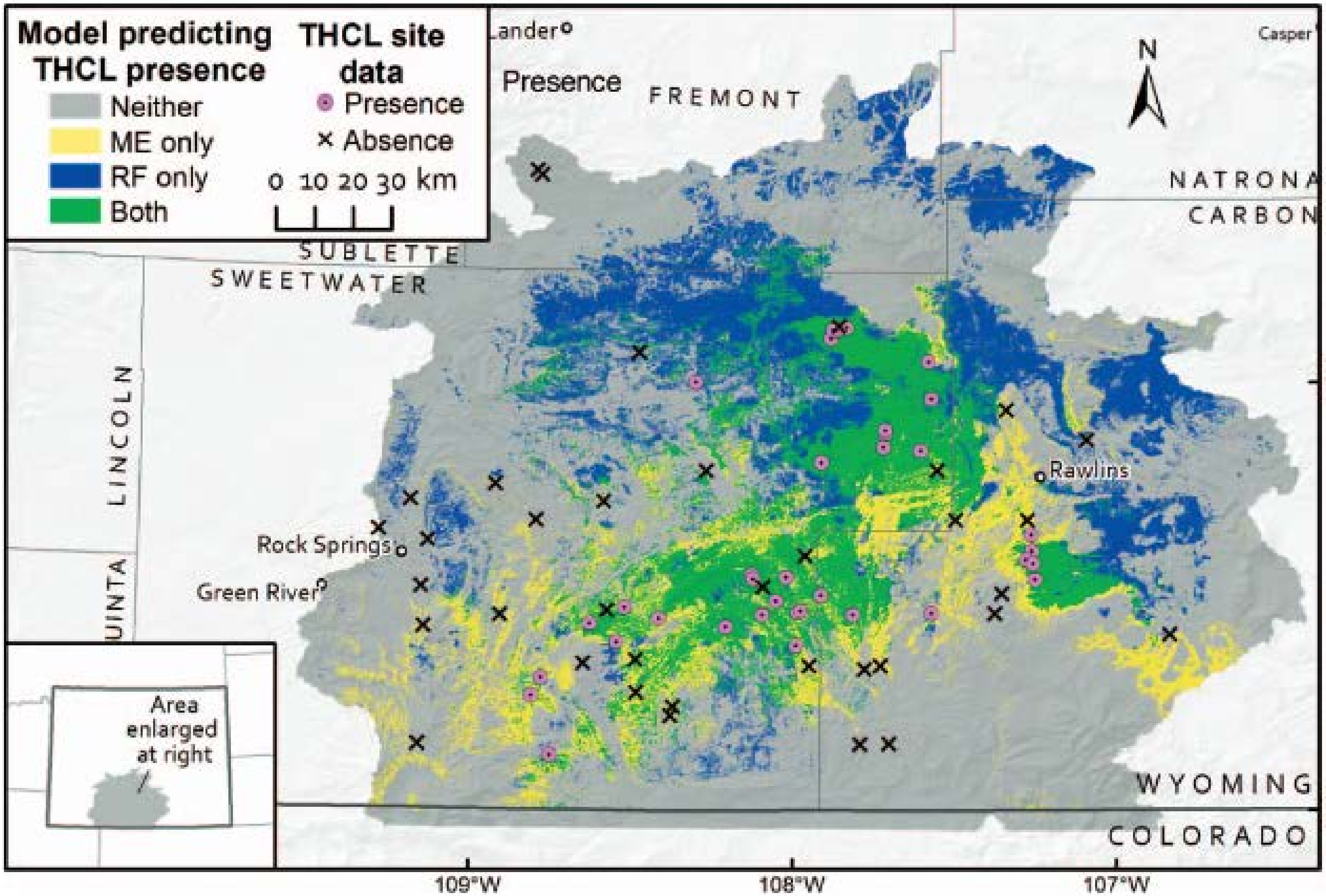


FIG. 3.—Overlay of distribution models of *Thomomys clusius* generated from recent pocket gopher surveys in Wyoming using Random Forests (blue) and Maximum Entropy (yellow), and sample locations on which the models were based. Areas of model overlap (green) are considered particularly likely to contain *T. clusius*.

PYGMY RABBIT
(*Brachylagus idahoensis*)

1981: Species first documented in WY

2000: 82 observation records at WYNDD

2003: Petitioned for ESA listing

2003: WYNDD produces initial distribution model

2004-5: Initial model used to document 812 new observations

2006: WYNDD updates distribution model

2007: Call for data from consultants; >5,000 new observations added!

2008: WYNDD updates distribution model

2009: WYNDD updates distribution model again

2010: USFWS decides listing not warranted

2014: 7,743 observation records at WYNDD

2014: WYNDD updates distribution model

Space-based observations: "existing data" or untapped monitoring resource?

Timothy Assal
Research Ecologist
Fort Collins Science Center
assalt@usgs.gov

USGS

Wyoming Landscape Conservation Initiative

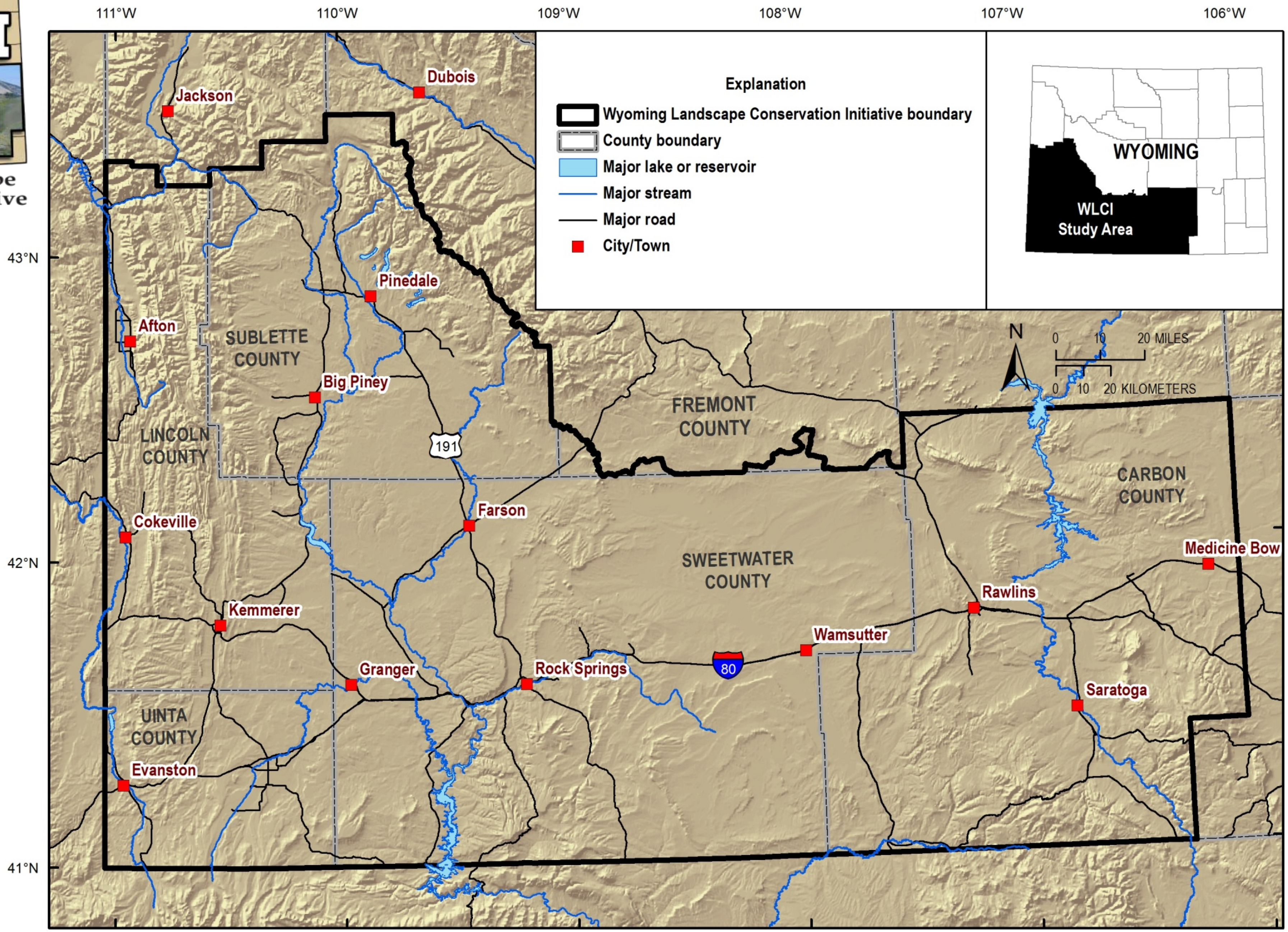
...multi-partner, long-term science-based program to assess and enhance the quality and quantity of aquatic and terrestrial habitats at a landscape scale in Southwest Wyoming, while facilitating responsible development.

Four regionally based Local Project Development Teams – provide local-level input and design of conservation actions

www.wlci.gov

WLCI

Wyoming Landscape Conservation Initiative



WLCI
Wyoming Landscape Conservation Initiative

Focus Communities

Aquatic

Riparian

Aspen

Sagebrush

Mountain Shrub

LPDT Concerns

- Aspen mortality (drought, sudden aspen decline, etc.)
- Conifer expansion
- Lack of aspen regeneration

LPDT Needs

- …information to help manage for future aspen
- …information about the condition and trends of aspen communities in the Little Mountain Ecosystem

How much aspen forest is on Little Mountain?

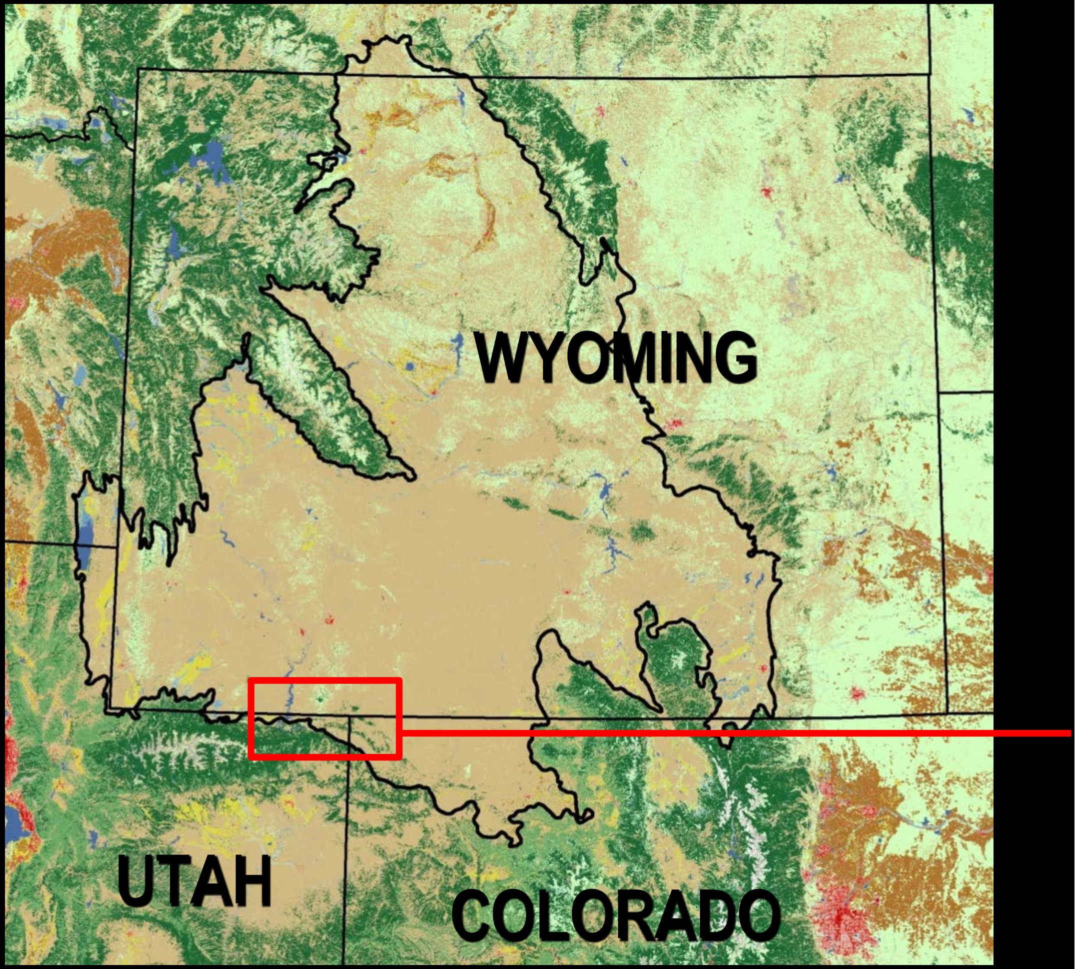
How much conifer forest is on Pine Mountain?

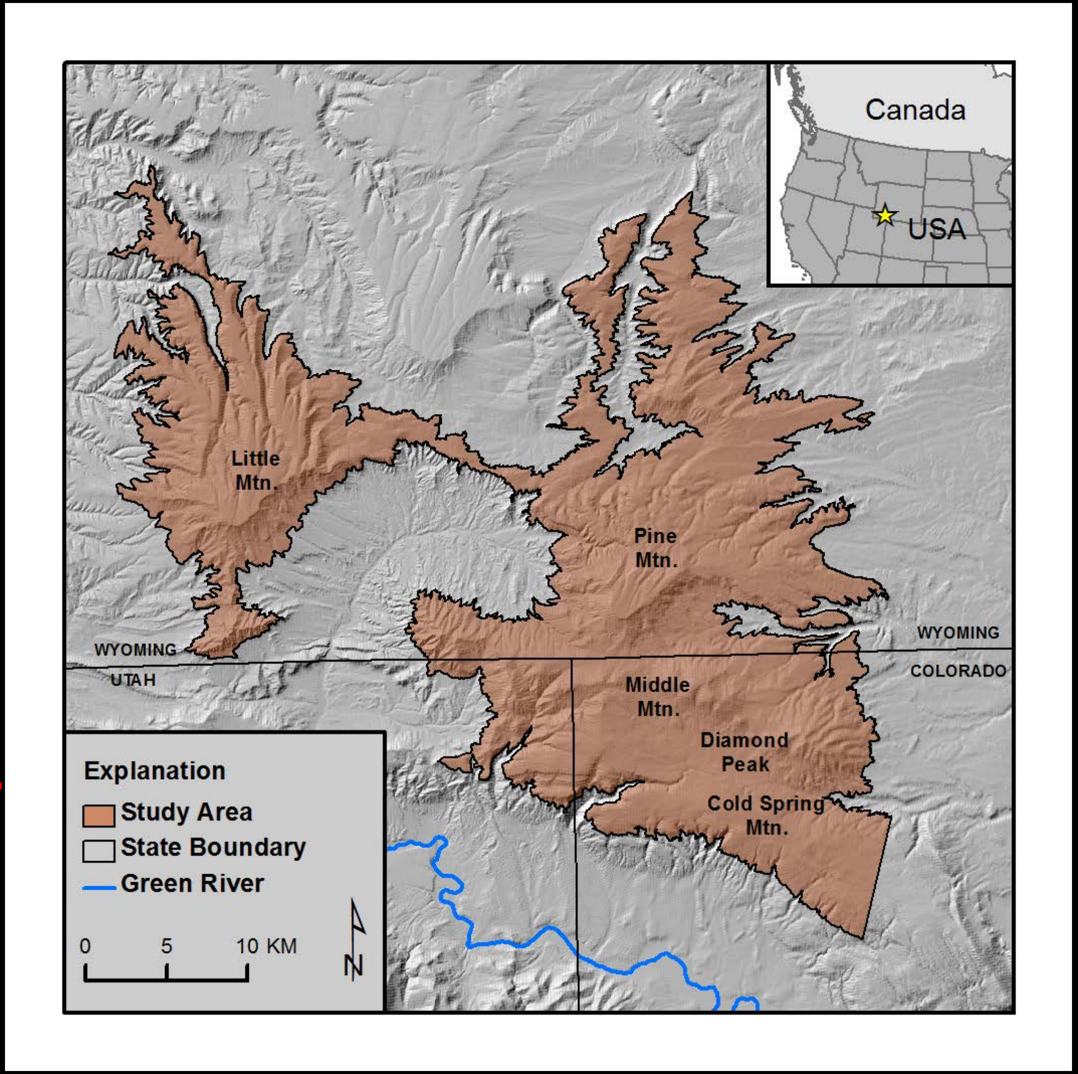
How much aspen forest is within X distance of conifer forest?

"If it doesn't get measured, it doesn't get managed."

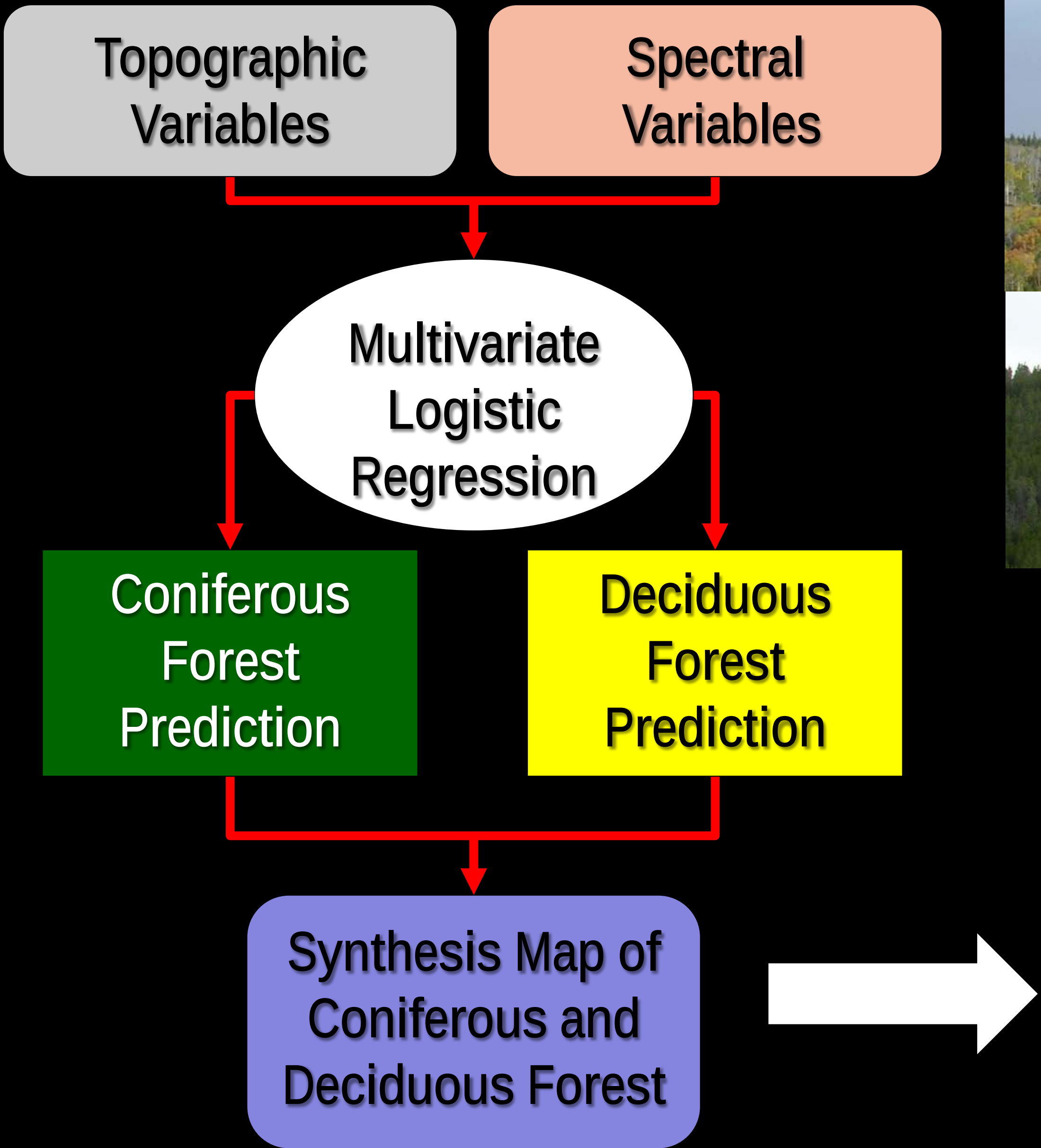
- ?

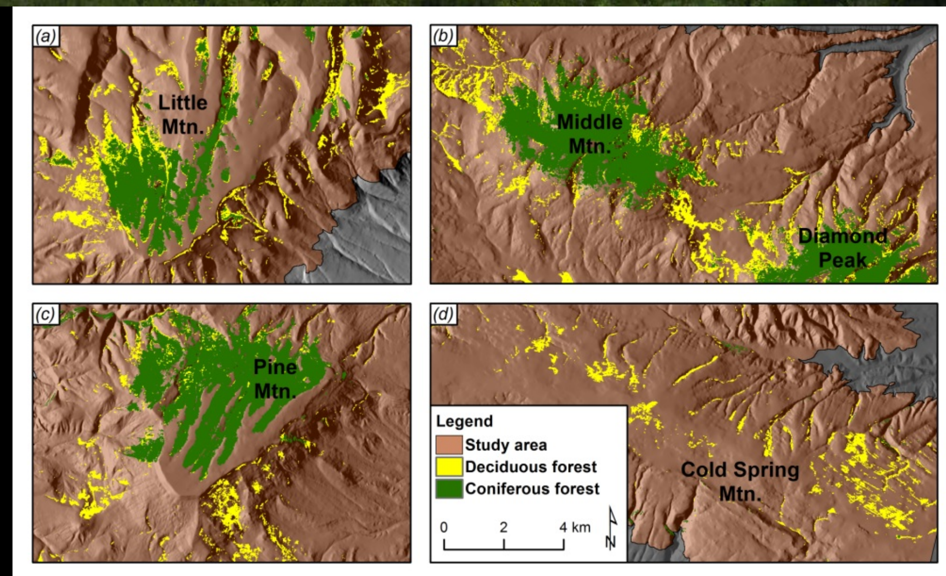
Location


WYOMING
UTAH
COLORADO


Canada
USA
Little Mtn.
Pine Mtn.
WYOMING
UTAH
WYOMING
COLORADO
Middle Mtn.
Diamond Peak
Cold Spring Mtn.
Explanation
Study Area
State Boundary
Green River
0
5
10 KM
N

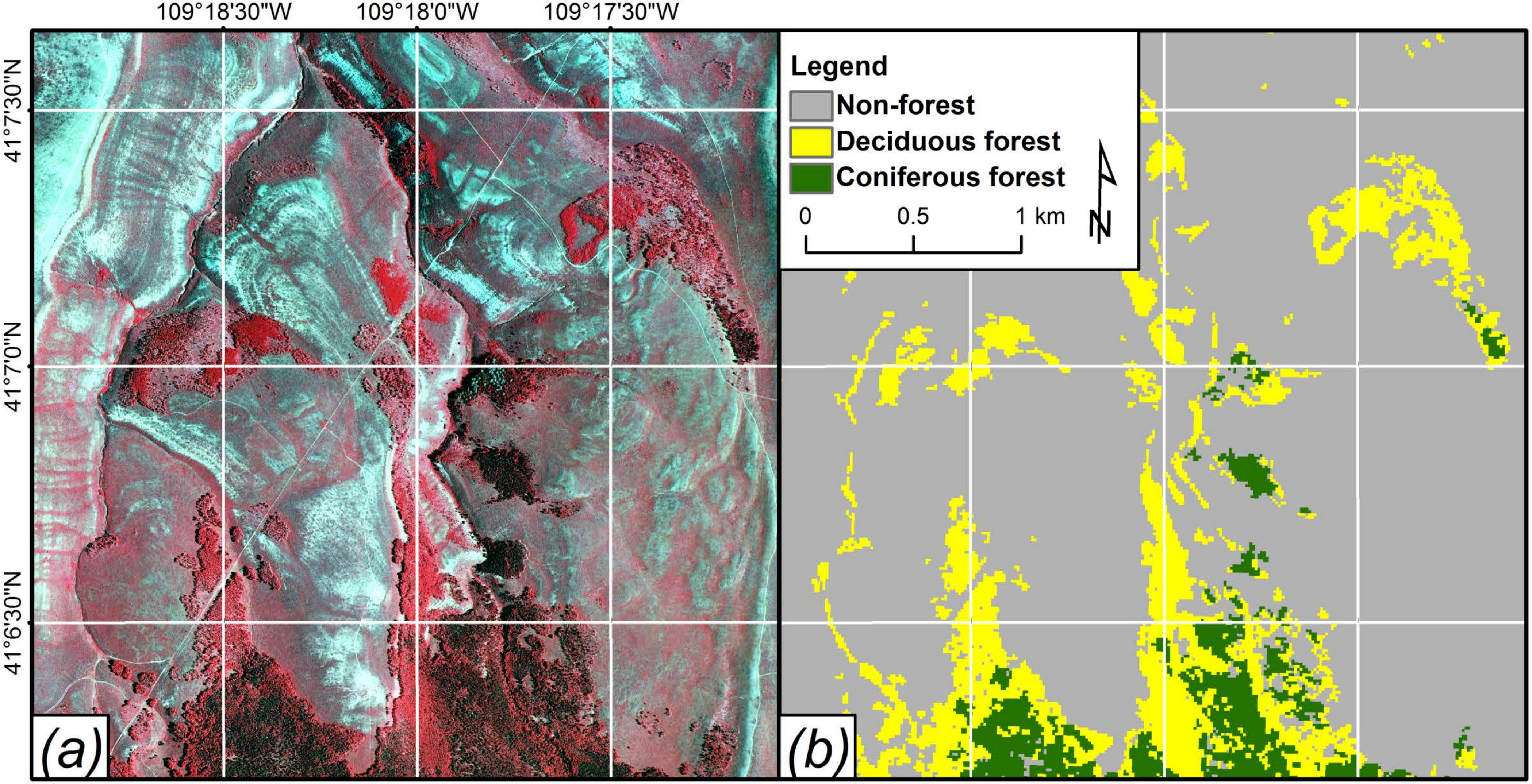
Mapping Forest Functional Type – Predictive Distribution Modelling





Assal et al. 2015, *Remote Sensing Letters*

Synthesis Map



Assal et al. 2015, *Remote Sensing Letters*

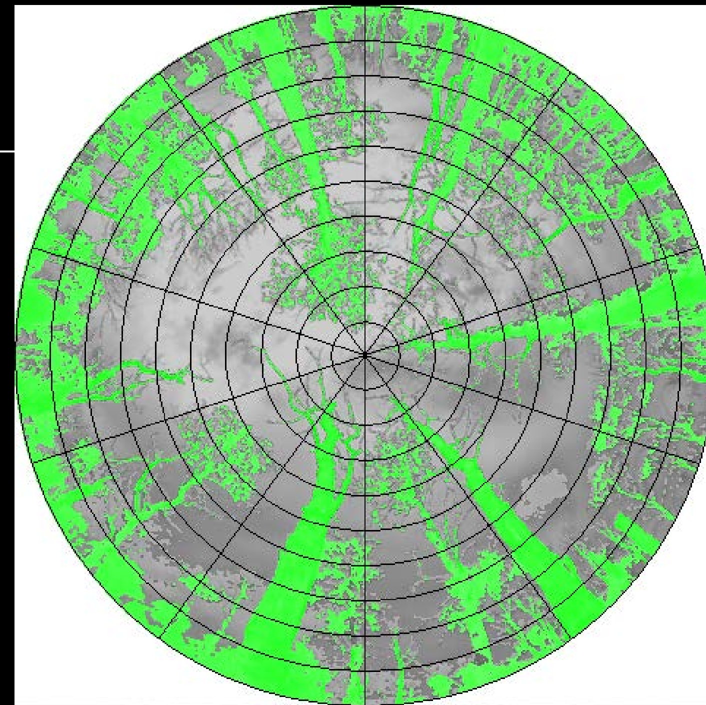
How do we get at condition and trends?

- Assess the relationship between satellite imagery and vegetation
- Backcast that relationship over time to identify forest change (location, direction and magnitude of change by forest type)
- Assess the underlying drivers of negative trends by cover type and topographic attributes

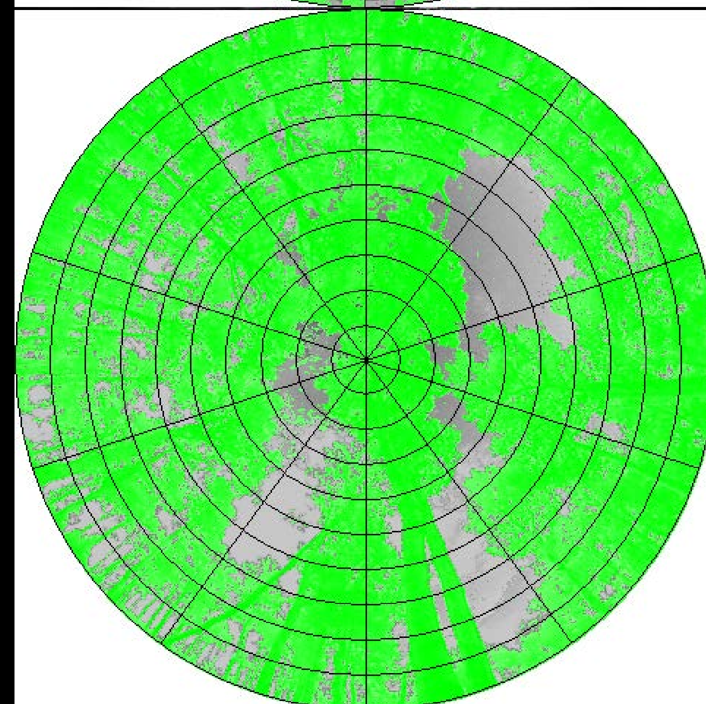
Little Mountain, WY

Ground Data

Scale up from plot to image…



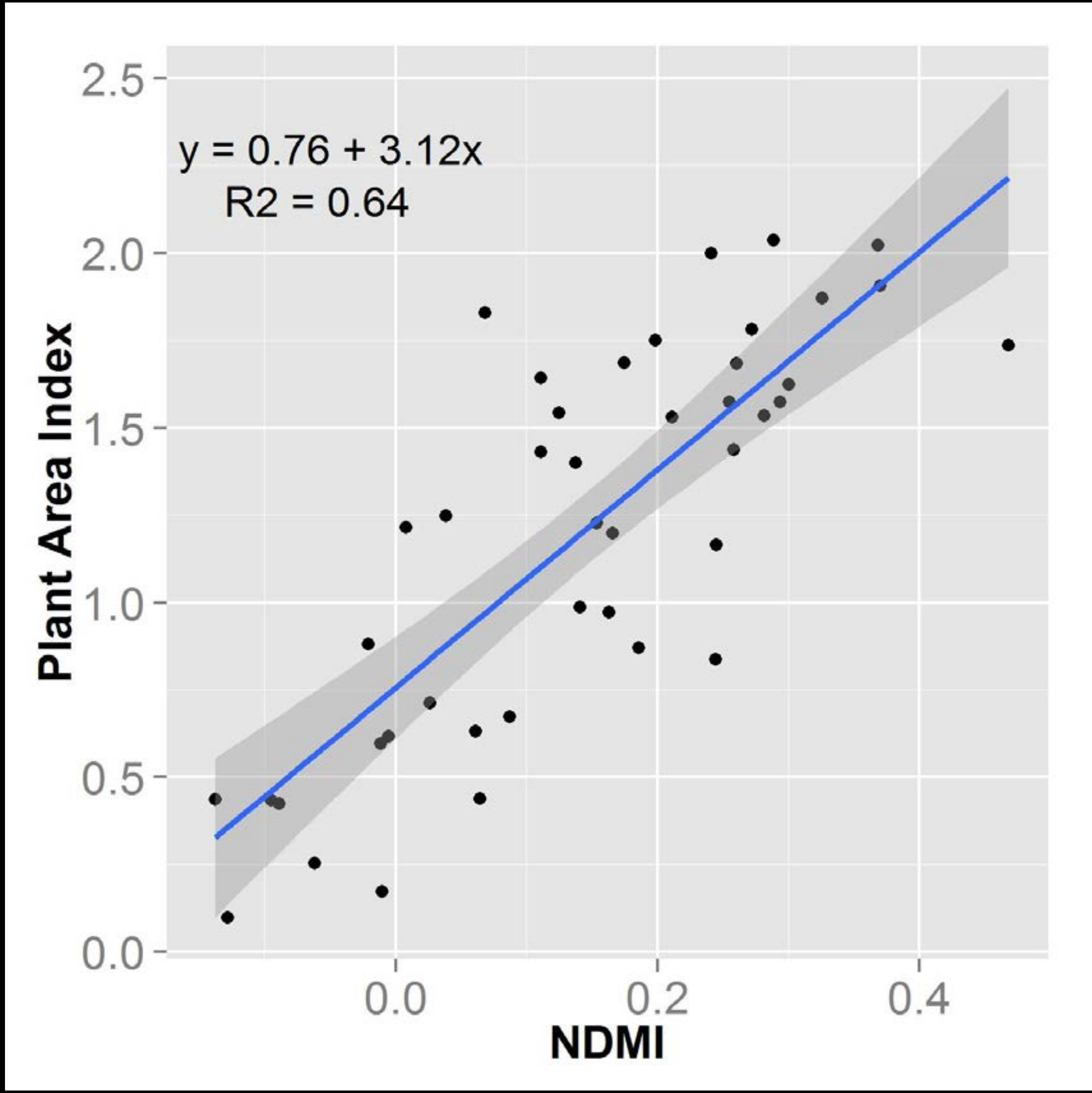
PAI = 0.30
CGF=0.76



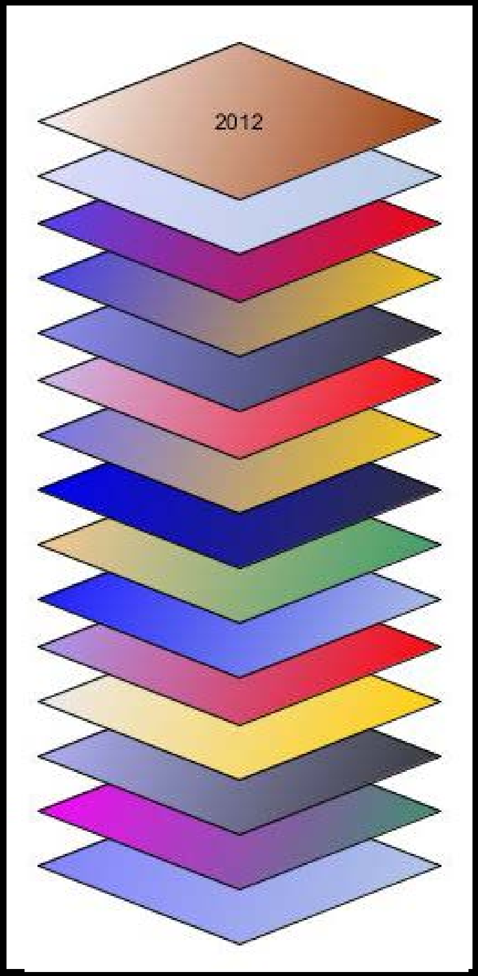
PAI = 1.67
CGF=0.25

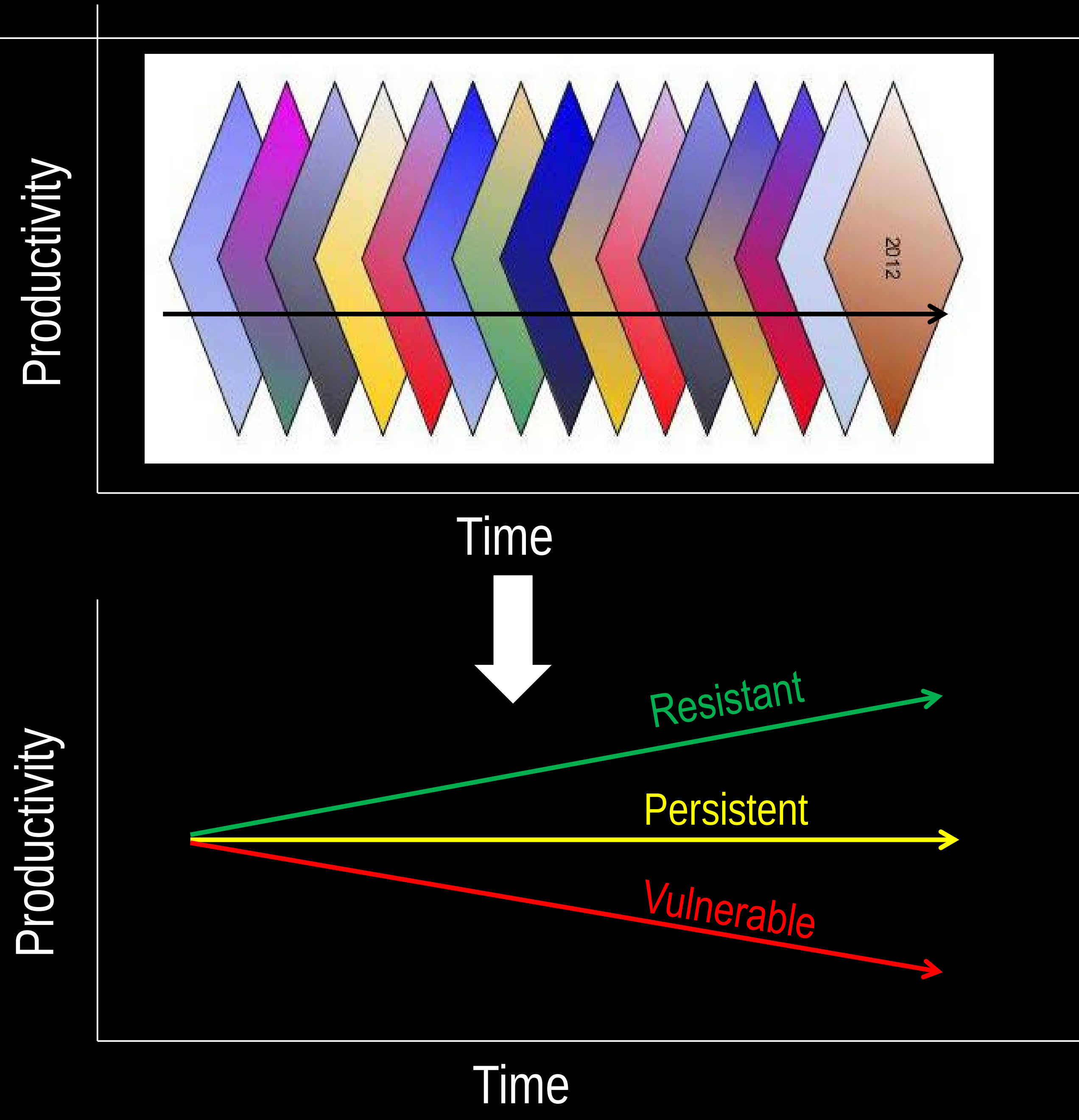
Results

- NDMI – a measure of vegetation water content
- NDMI explains 64% of variability in field data
- Short term field data, correlate with long term field data

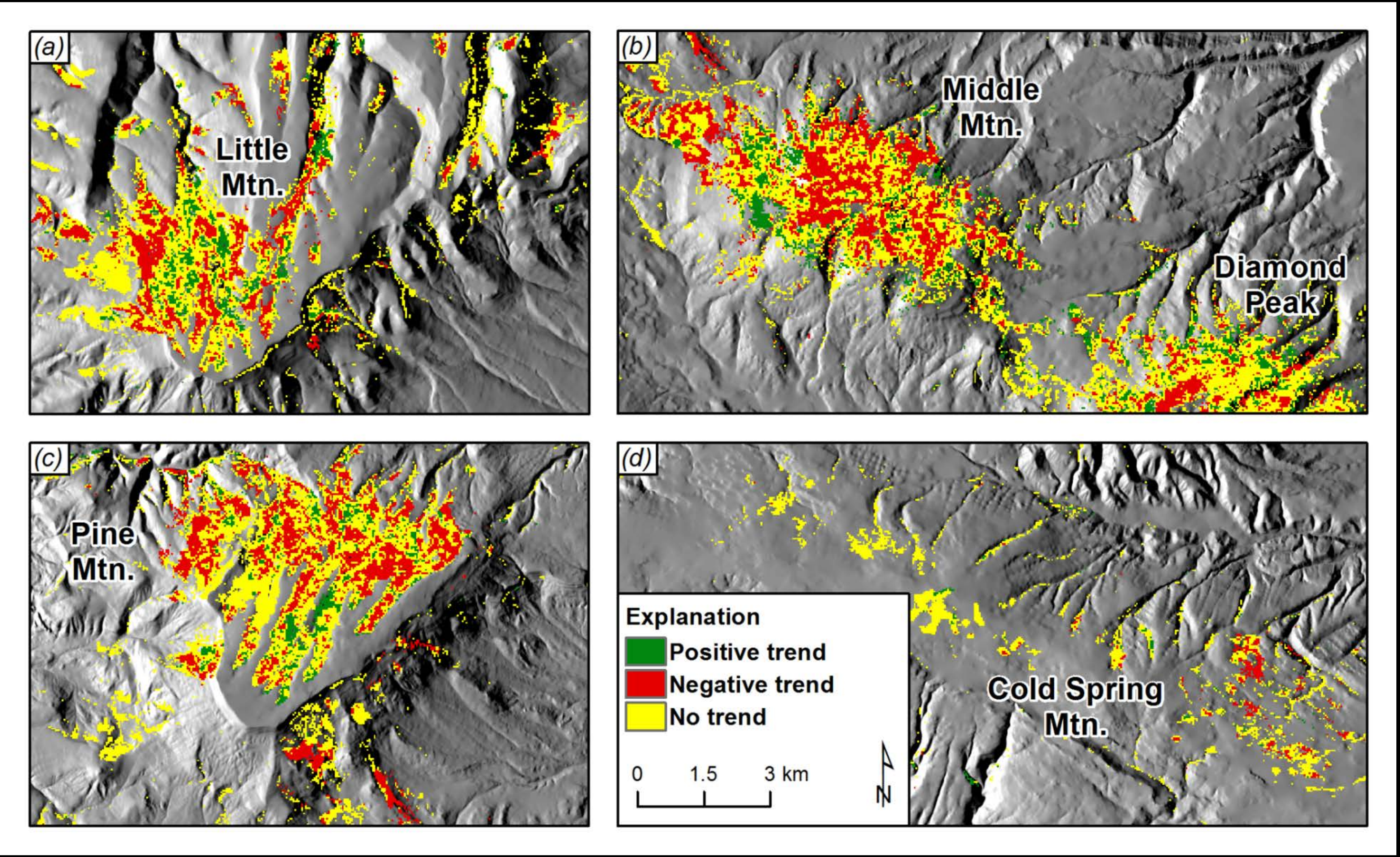


Linear Trend Analysis





Linear Trend Analysis – Results



Assal et al. 2016, *Forest Ecology and Management*

Ground Based Evidence

- Plots with statistically significant negative trend: lower live density and higher amounts of standing dead and down trees

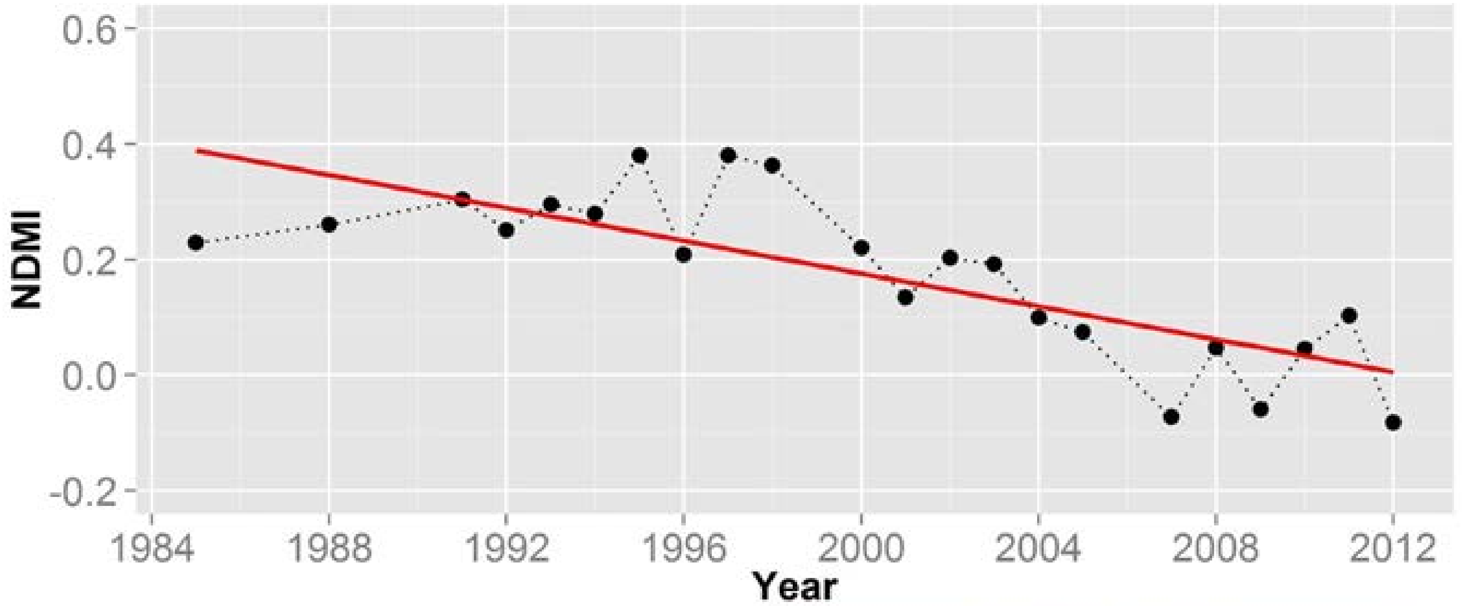
Ground Based Evidence

PAI = 0.43

CGap = 0.64

Live BA = 12.8 m^2/ha

Mortality = 81.5%



Assal et al. 2016, *Forest Ecology and Management*

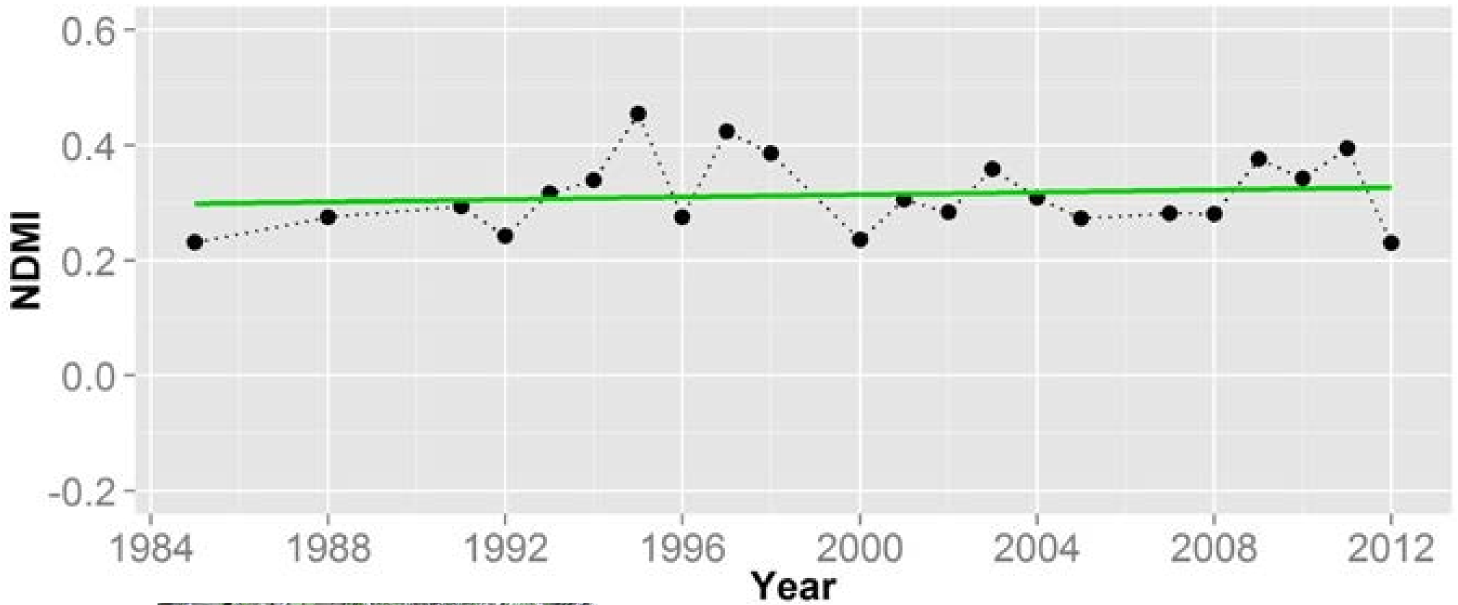
Ground Based Evidence

PAI = 2.02

CGap = 0.20

Live BA = 37.3 m^2/ha

Mortality = 20%



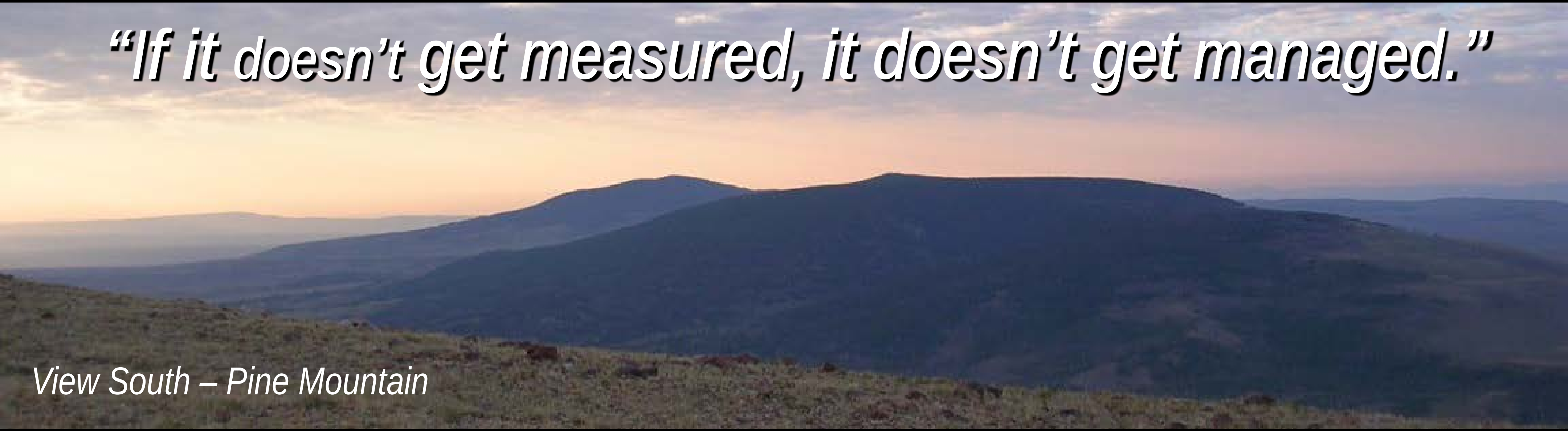
Assal et al. 2016, *Forest Ecology and Management*

Management Applications

- Help provide managers with answers:
- How many acres of aspen forest is located in…?
- Identify potential areas for treatment and no-treatment.
- Where to monitor?
- Science to support management using open access data and tools
- Identify opportunities to work across jurisdictional lines

Little Mountain, WY

View North - Pine Mountain, WY



Broad scale monitoring or monitoring at broad scales?

Questions?

Tim Assal
assalt@usgs.gov

Patrick Anderson
andersonpj@usgs.gov
WLCI

Zack Bowen
bowenz@usgs.gov
USGS Ecosystem Dynamics

fin

Mapping invasive cheatgrass in post-burn landscapes

The Squirrel Creek Wildfire (SCW)

- The SCW disturbed 4,450 ha in Medicine Bow National Forest, Wyoming in 2012
- Establishment and spread of invasive cheatgrass (*Bromus tectorum*) is a major concern in post-burn area
- The SCW encompass crucial winter habitat for mule deer (*Odocoileus hemionus*) and elk (*Cervus Canadensis*)
- Detailed maps of cheatgrass distribution are needed to assess focus areas for targeted management

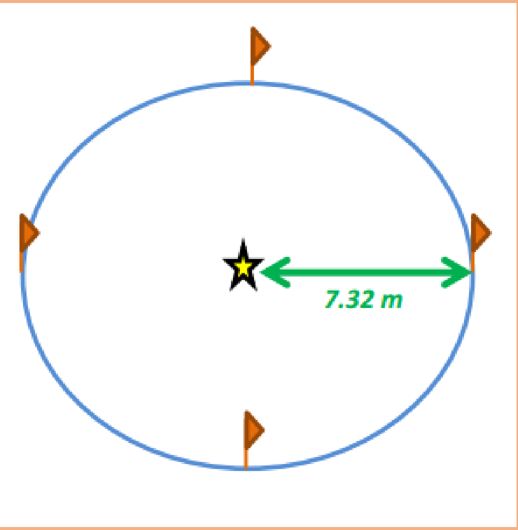
Why is cheatgrass problematic?

- alters nitrogen cycling
- depletes soil water content
- interspecific competition with native grass and forb species
- degrades range site productivity, wildlife forage and habitat quality
- lengthens fire season with increases in fire frequency
- increases fire intensity at ground level

Methods

Initial Field Data Collection:

- May 2014 - July 2014 conducted field surveys in SCW
- sampled 7.32 m plots (Stohlgren et al., 2010) randomly stratified (Hirzel and Guisan, 2002) across North-South transects, spaced 1,000 m apart (n = 184 plots)
- all samples taken at a distance greater than 30 m from the next closest sample (i.e. to minimize spatial autocorrelation; corresponds with 30 m^2 Landsat pixel resolution)
- recorded cover:
  - % cheatgrass
  - % woody/shrub
  - % other grass/forb
  - % bare ground
  - % rock



Hirzel, A and Guisan, A 2002. Ecological Modelling 157: 331-341
Stohlgren, TJ et al. 2010. Beyond N. American Weed Manage. Assoc. Standards 1-10

Species Distribution Models (SDMs)

- Relate **presence** or **presence & absence** of species in geographic space with **environmental variables;** predict **distributions** back into **geographic space**
- Other SDM terms: habitat suitability model, bioclimatic niche model, environmental suitability model

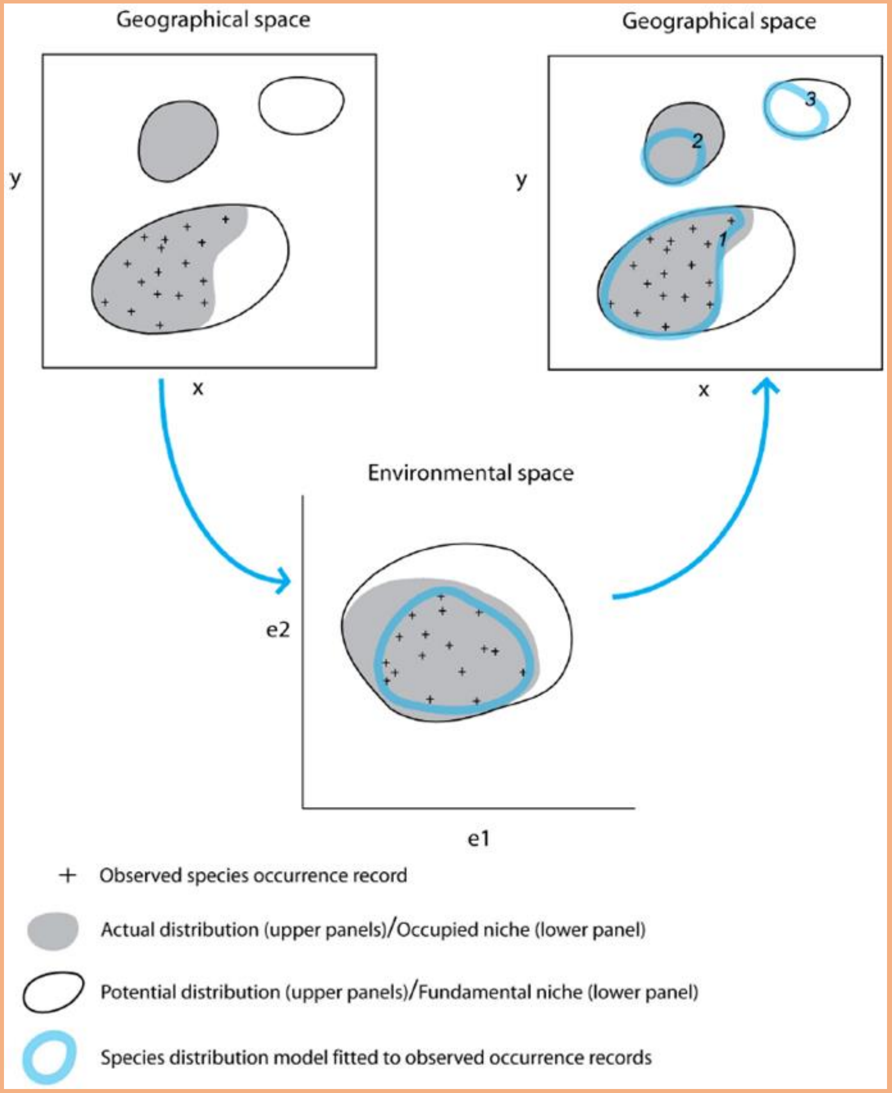
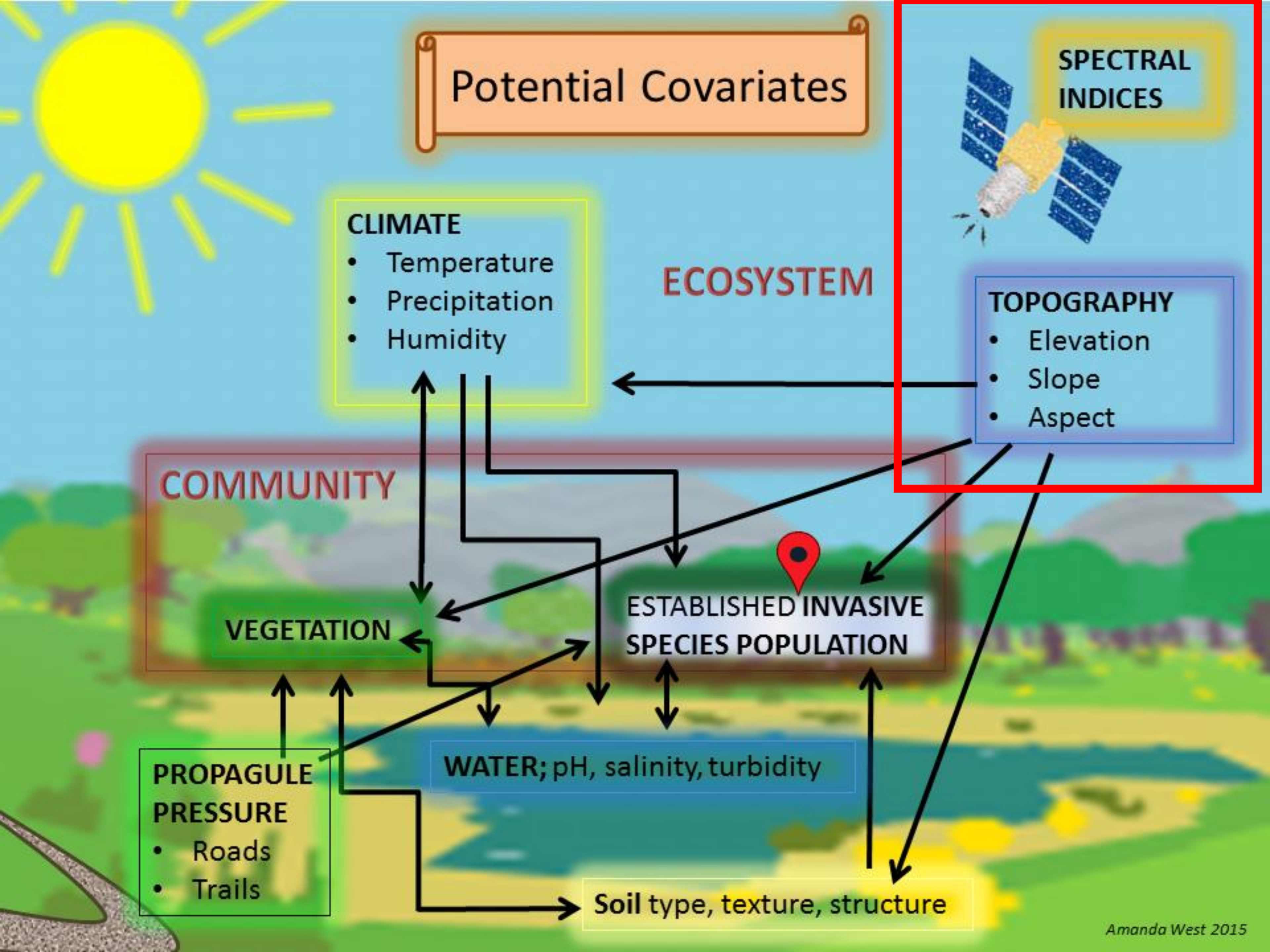
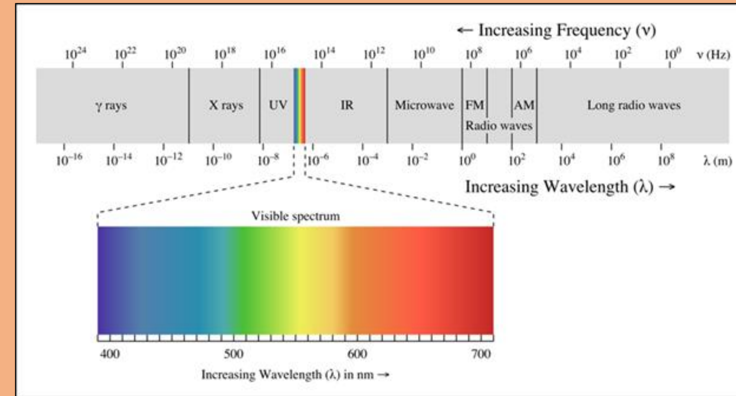


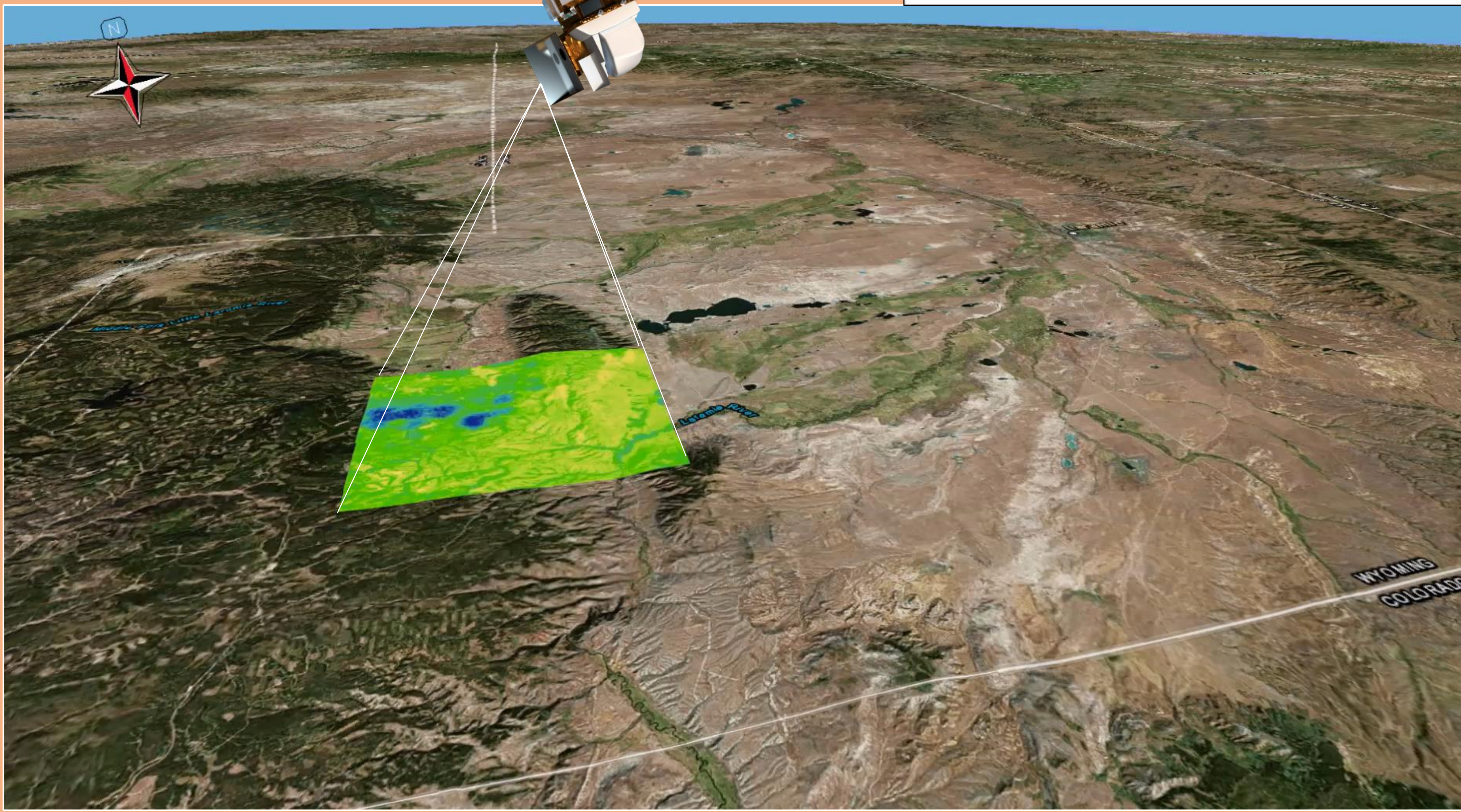
Figure from Pearson, RG 2007. Species' Distribution Modeling for Conservation Educators and Practitioners. Synthesis. American Museum of Natural History. http://ncep.amnh.org


Potential Covariates
SPECTRAL INDICES
CLIMATE
• Temperature
• Precipitation
• Humidity
ECOSYSTEM
TOPOGRAPHY
• Elevation
• Slope
• Aspect
COMMUNITY
VEGETATION
ESTABLISHED INVASIVE SPECIES POPULATION
PROPAGULE PRESSURE
• Roads
• Trails
WATER; pH, salinity, turbidity
Soil type, texture, structure
Amanda West 2015

A cheatgrass population is spectrally distinct at three stages in its annual lifecycle; “boot stage” or formation of grass spikelets; “purple to red stage” and “brown stage” to senescence – thus, we used spectral indices derived from multiple months (i.e. May – Sept. 2014) of Landsat 8 imagery to distinguish cheatgrass from other species on the landscape

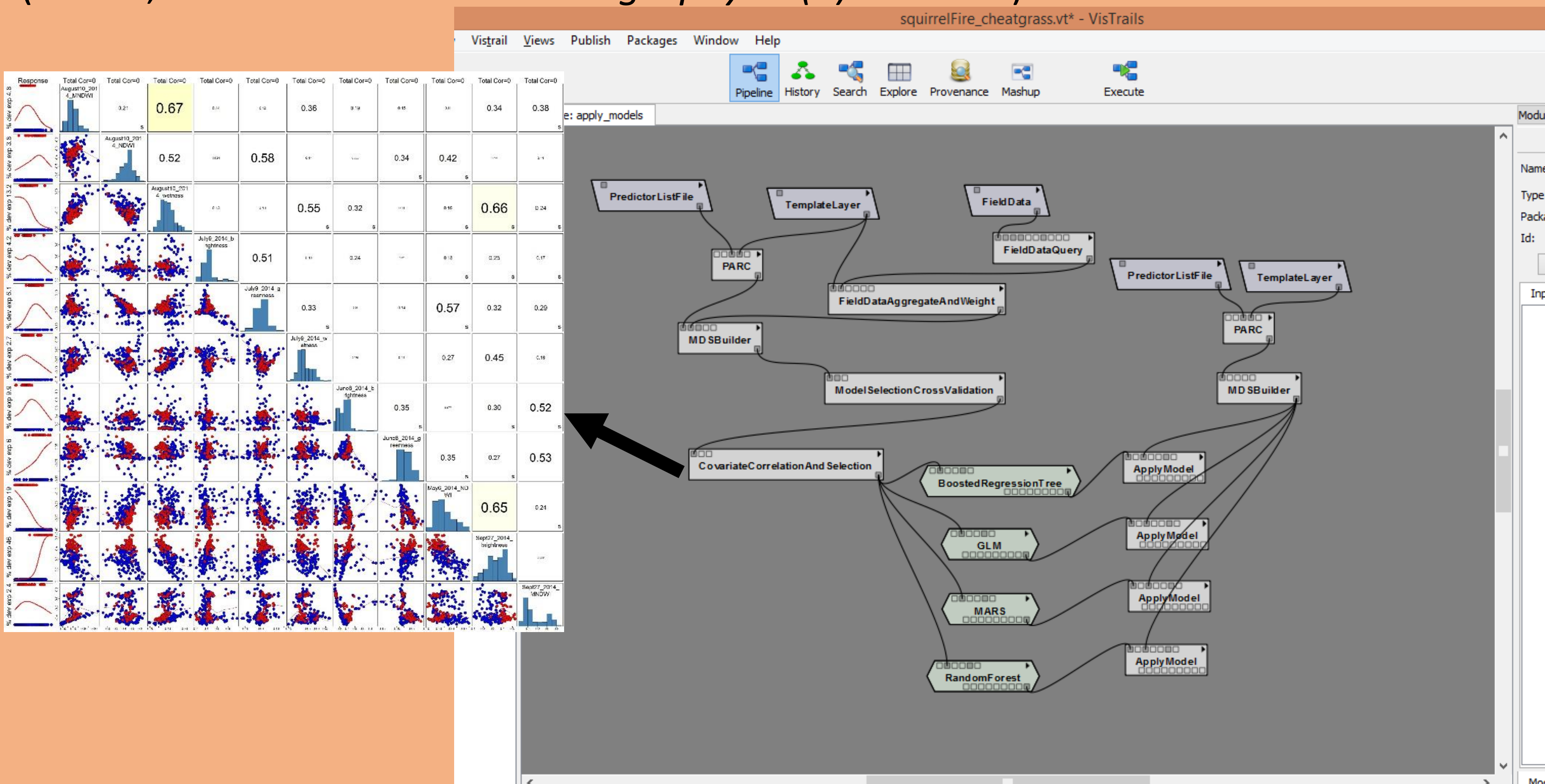
Spectral indices of reflectance and transmittance of visible & near infrared (IR) frequencies: NDVI; SAVI; EVI; NDWI; MNDWI; Tasseled cap brightness, greenness & wetness





Methods, continued

- Executed **Random Forests**, **Boosted Regression Trees**, **Generalized Linear Models**, and **Multivariate Adaptive Regression Splines** species distribution models using the multi-temporal, multispectral indices from Landsat 8 imagery and cheatgrass presence and absence data in the USGS Software for Assisted Habitat Modeling (SAHM; *Morisette et al. 2013 Ecography 36(2) 129-135*)

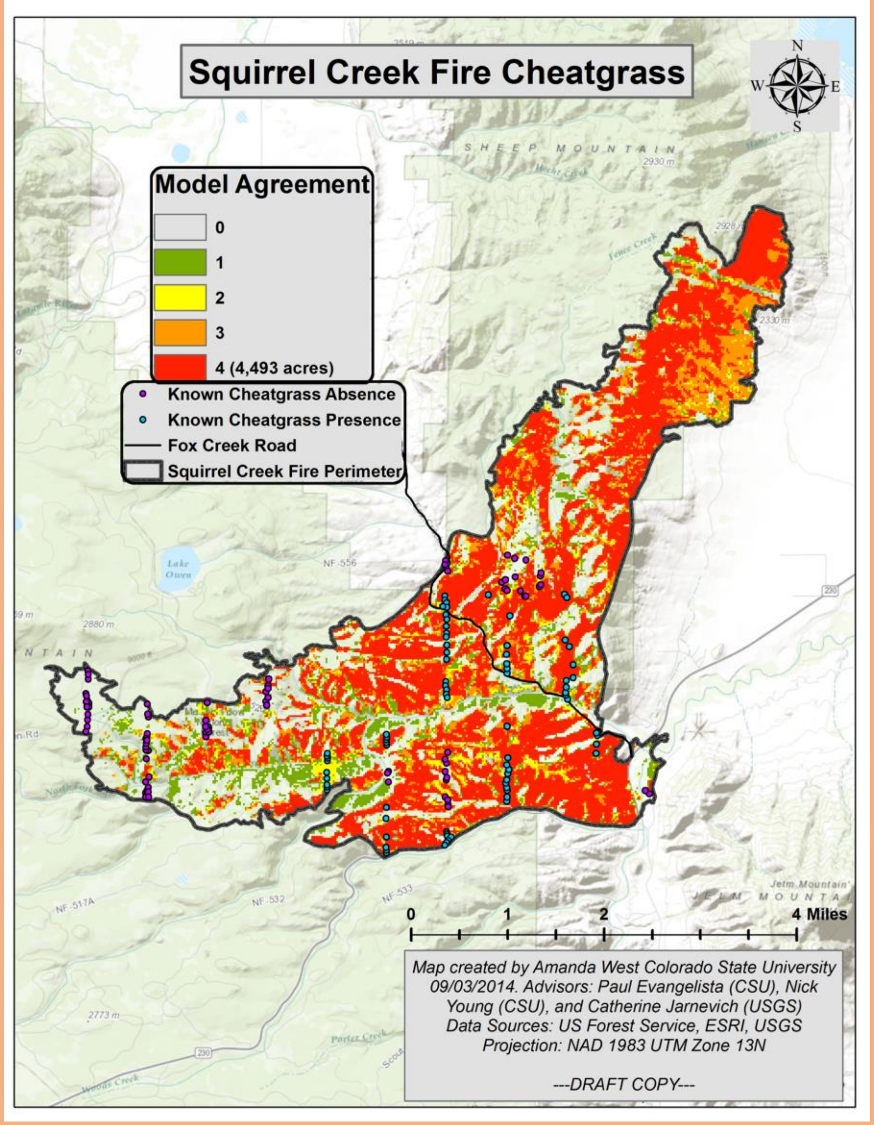


Preliminary Results

- Ensembled (averaged) the four models to see where they agreed
- Primary objectives in developing preliminary ensemble models:

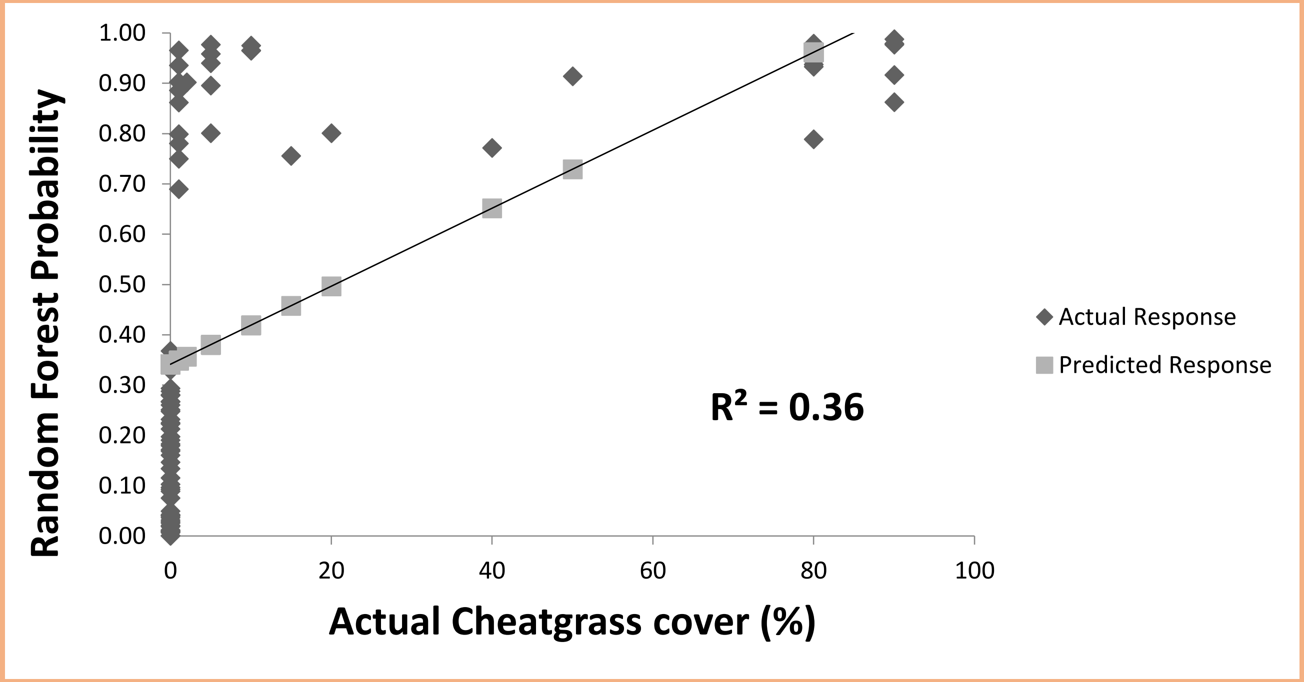
(1) to prioritize areas for additional sampling to test model results based on multivariate environmental similarity surface (MESS) map and input from meeting with Forest Service

(2) as a basis for developing a threshold for percent cheatgrass cover necessary for detection at the 30 m^2 spatial resolution of Landsat 8 imagery



Methods, continued

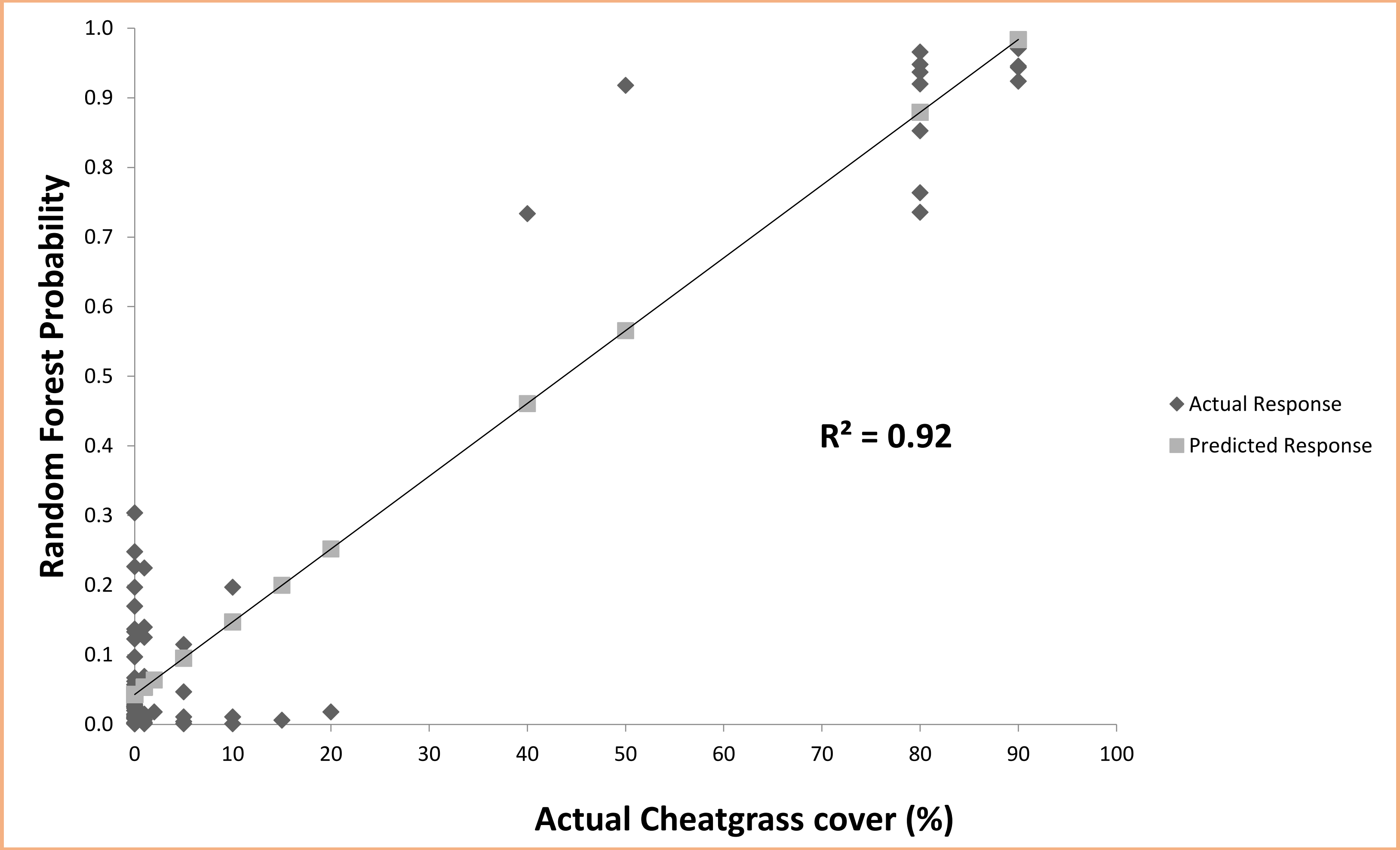
- To determine a threshold for percent cover necessary to distinguish spectral reflection and absorption of *B. tectorum* from other vegetation, extracted values from probability surface produced by Random Forests prelim. model at locations where independent test data were collected in Sept. (n=81)
- We used a simple linear regression to evaluate how well this model predicted percent cheatgrass cover from these locations.



Methods, Part 2

- Chose a 40% threshold for cheatgrass cover to be considered "presence"
- Based on the simple regression model in concert with the minimum amount assumed detectable by the Landsat 8 OLI sensor and potential management objectives.
- Re-ran all four models (i.e. RF, BRT, GLM, and MARS) using presence as 40% cheatgrass cover or greater

Final Random Forest model fit with points where cheatgrass ≥ 40% cover had 0.93 sensitivity and 0.88 specificity



Final Results from Random Forest model

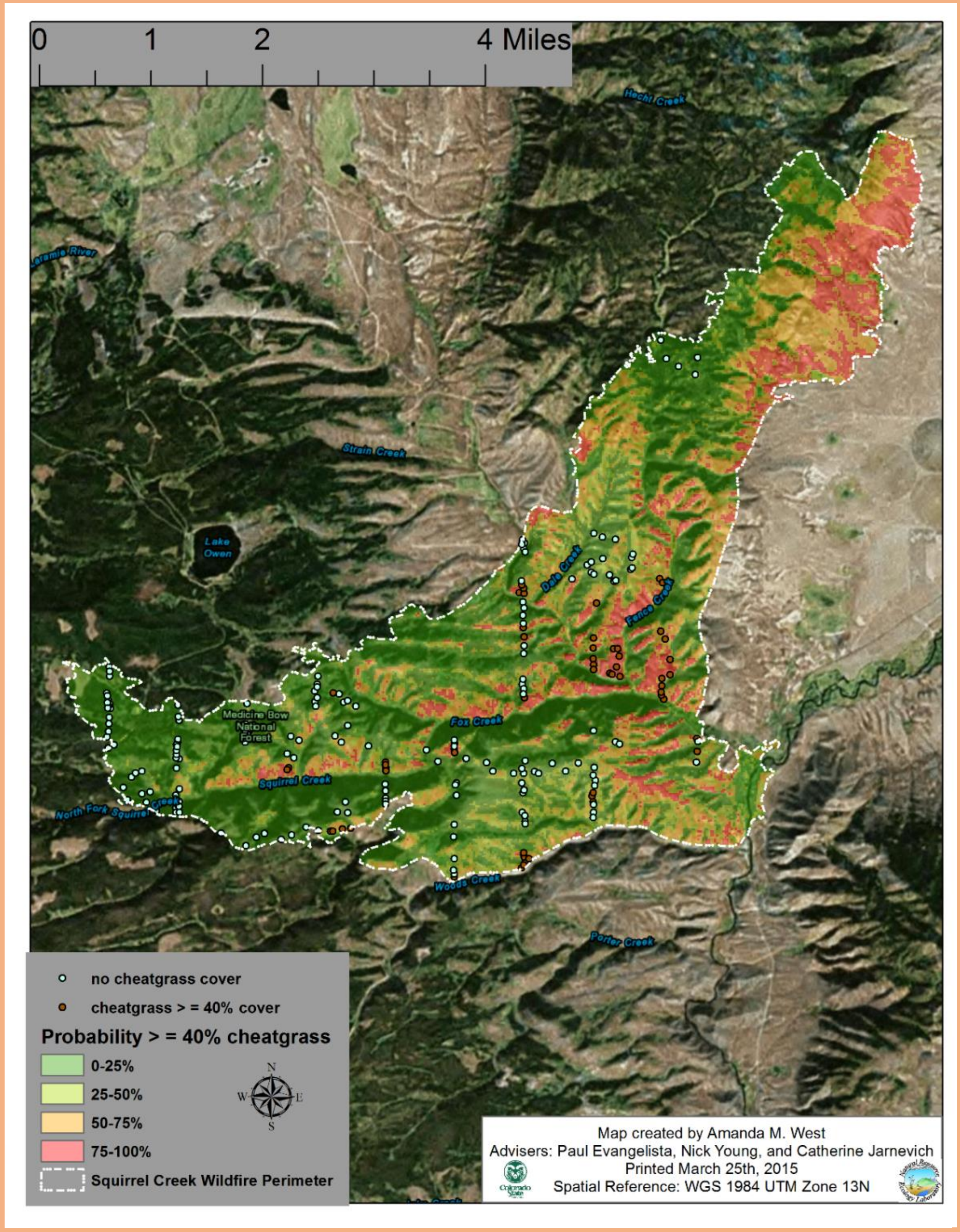
probability of cheatgrass cover ≥ 40%:

0-25% = 6002 acres

25-50% = 1508 acres

50 - 75% = 1975 acres

75 - 100% = 1191 acres



Variable Importance in Final Random Forests Model

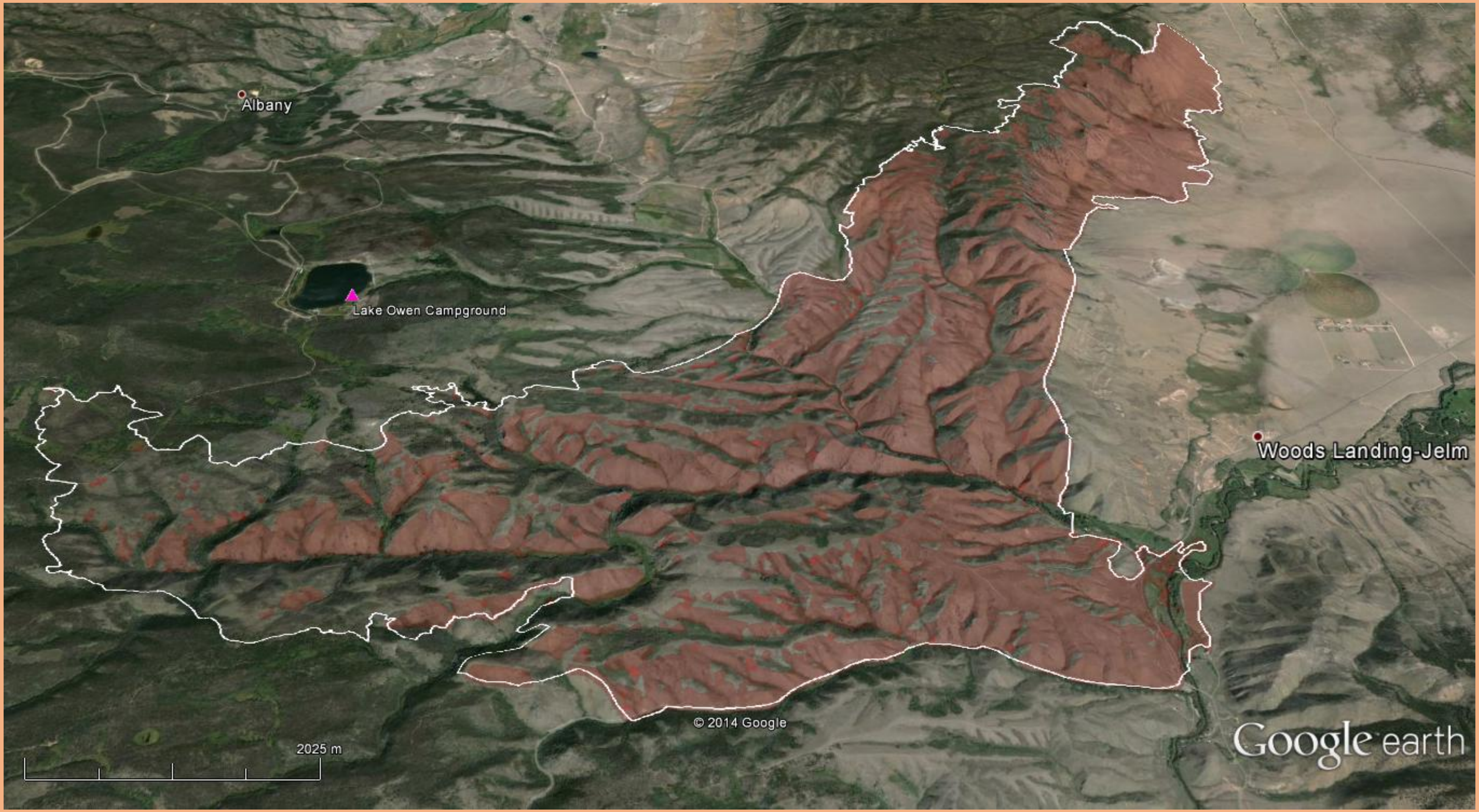
Variable	Mean Decrease Accuracy	Mean Decrease Gini
September TCAP bright	**31.47**	**8.31**
June TCAP bright	**19.16**	**4.87**
June TCAP green	**15.36**	**3.81**
August TCAP wet	**13.60**	**3.42**
September MNDWI	**12.30**	**2.92**
July TCAP green	**10.94**	**2.65**
May NDWI	**10.90**	**3.55**
July wet	**8.66**	**2.85**
July bright	**8.02**	**2.74**
August MNDWI	**7.40**	**2.40**
August NDWI	**7.27**	**2.70**

Most important covariate in all models

Potential Suitable Habitat

- Fit the same four models with topographic covariates rather than remotely sensed indices:
  - elevation, slope, second derivative of slope, COS transformation of aspect, compound topographic index (CTI), and heat load index (HLI)
- Created a buffer around the final RF model of current cheatgrass distribution based on the maximum distance that cheatgrass seeds may disperse via wind in areas following fire (i.e. 2.13 m; note this does not account for other modes of dispersal including mammal fur)
- Clipped an ensemble of the four models using the buffer

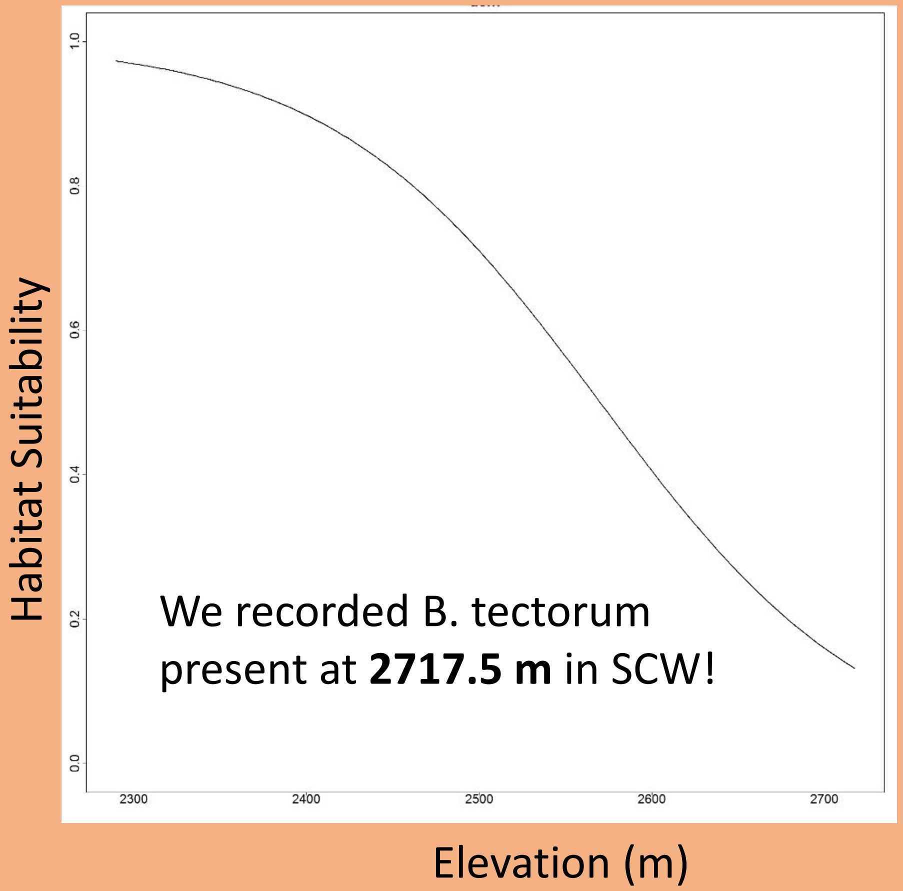
Potential Suitable Habitat of *B. tectorum* in Squirrel Creek Wildfire



Response of B. tectorum to soils and topography

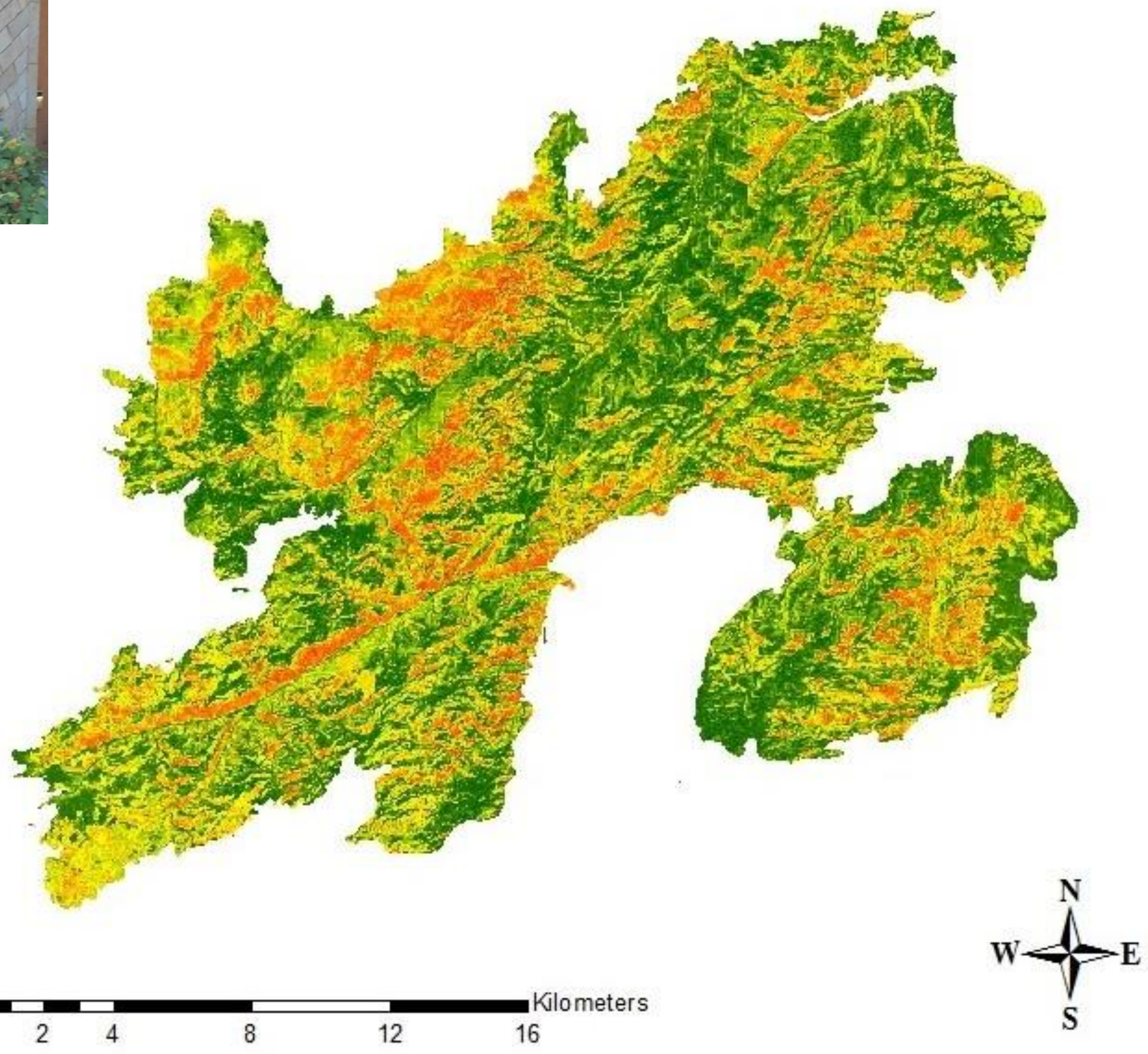
- Also evaluated a soils layer provided by the USFS to include in the habitat suitability model; however, none of the models related soil texture to *B. tectorum* presence or absence
- Noted three taxonomic classes where present; **gravelly sandy loam** to **very gravelly sandy loam** and **very cobbly loam**
- Topographic covariates stand as proxies for water collection and soil attributes on the landscape
- The two most important topographic covariates across models were **elevation** and **COS** (cosine transformation of aspect)

Response Curve from GLM model



Fall 2015 NASA DEVELOP Team at CSU developed similar SDMs for Arapaho wildfire

The team won a national competition for best Fall 2015 NASA DEVELOP video: **http://earthzine.org/2015/11/25/a-changing-landscape-monitoring-cheatgrass-with-satellite-imagery/**



Questions???

Special thanks to the U.S. Forest Service, Wyoming Game and Fish, the USGS Fort Collins Science Center, and everyone who assisted with field data collection!

West AM *et al.* (*In Review*). Developing distribution maps for invasive species in post-wildfire landscapes using methods relevant to land management.