LANDFIRE: a nationally consistent and locally relevant fire, fuels and risk assessment

NWCG Geospatial
Task Group
Orlando, Florida
November 16, 2003

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Sioux Falls, SD

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Missoula, MT

LANDFIRE: A History

Fall 1999 – Missoula Fire Sciences Laboratory asked by USFS F&AM to provide fine scale Nationally consistent FRCC data.

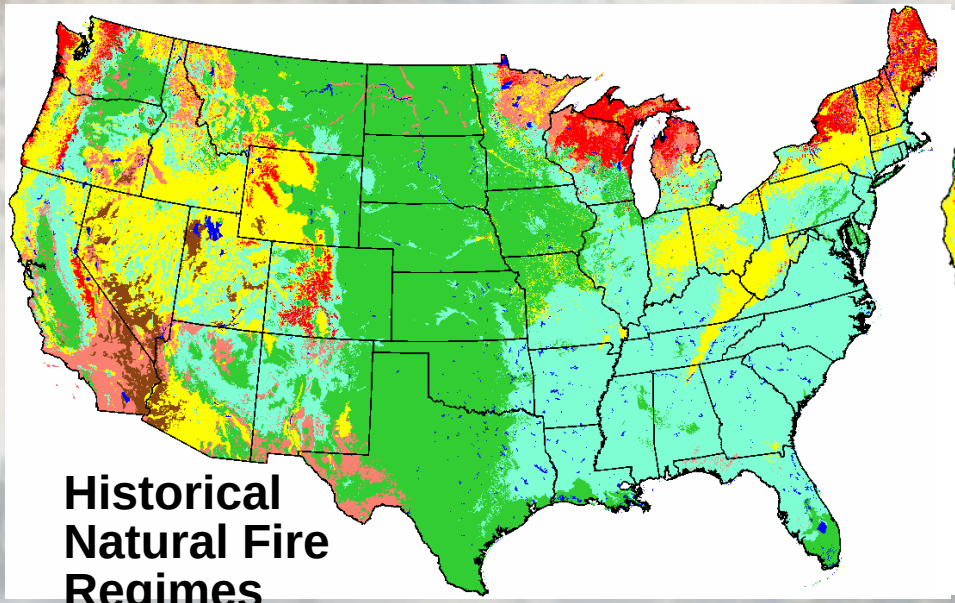
Spring 2001 – LANDFIRE Prototype funded.

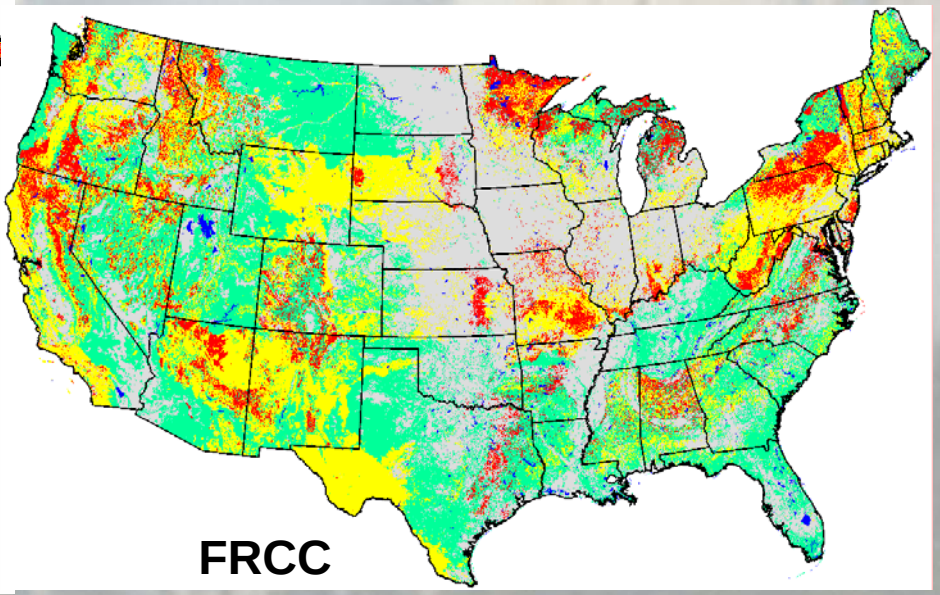
- USGS-EDC and MFSL to prepare methods frameworks and prototype LANDFIRE deliverables for 2 areas.

Roberts Fire
Glacier National Park
August 2003

1999 – Coarse Scale Data Layers

Helped address GAO Concerns regarding lack of comprehensive data.

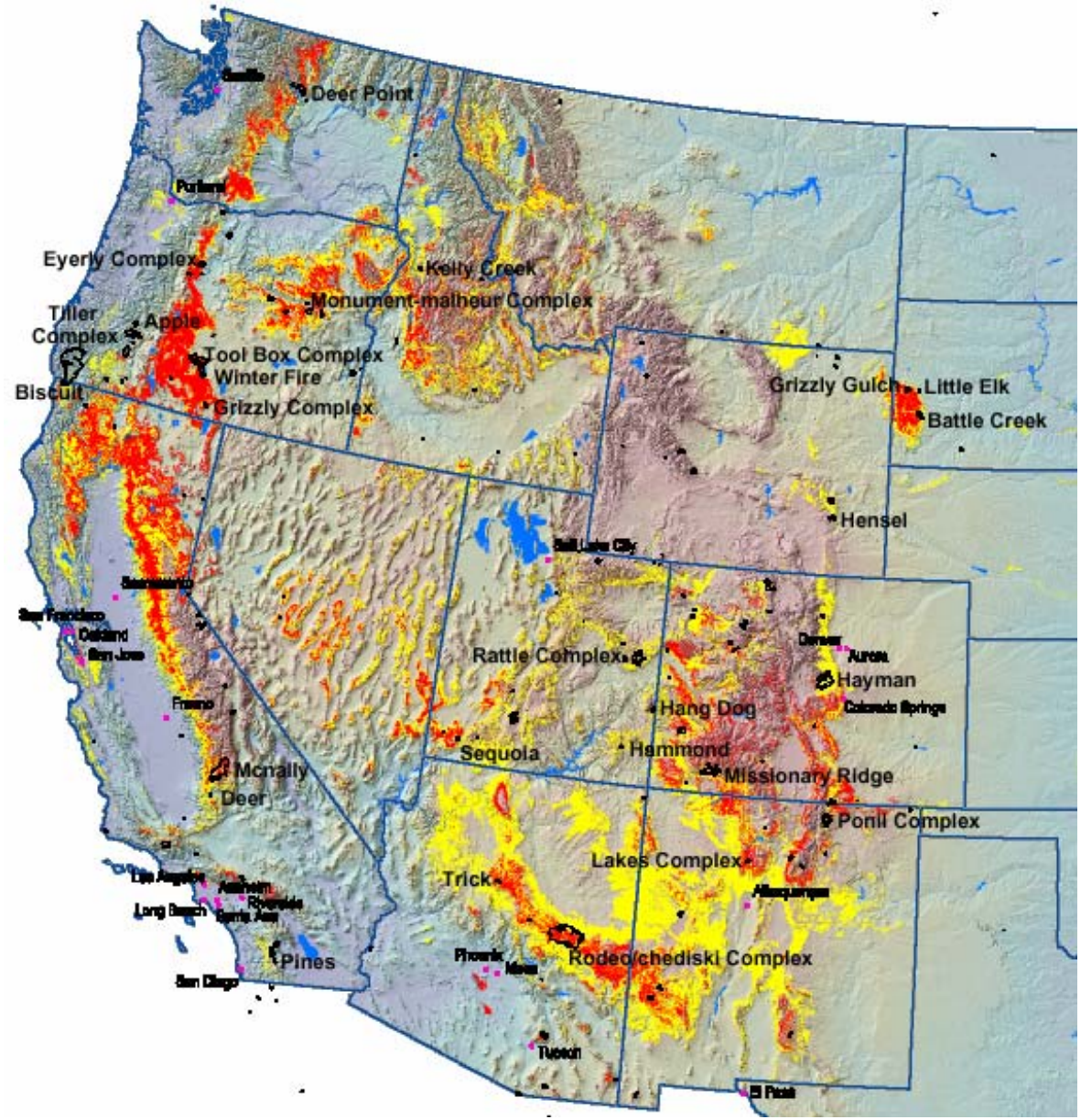




Frequency	*Severity*
0-35 year	Low
0-35 year	Stand Replacement
35-100+ year	Mixed
35-100+ year	Stand Replacement
200+ year	Stand Replacement

Fire Regime Condition Class 1
Fire Regime Condition Class 2
Fire Regime Condition Class 3
Water
Ag & Non Vegetative Areas

1Km FRCC overlay with major 2002 Fires



Large fire locations by fire regime condition classes 2 and 3 for Historical Natural Fire Regime I (0-35 years, low severity)

LANDFIRE: A History

March 2002 – LANDFIRE Prototype Funded

March 2003 – National implementation ??

- Proposed timeline and budget for presented to DOI and USFS fire staff in DC.
- USFS F&AM decides to move ahead with funding

October 2003 – National Implementation

- Wildland Fire Leadership Council agrees to oversee National Implementation beginning FY04

What is LANDFIRE

National fire plan requires consistent, comprehensive, and impartial data and analysis tools.

LANDFIRE provides mapped FRCCs, fuels characteristics, and vegetation condition.

LANDFIRE is a foundation for Landscape and Fire Management Planning based on current peer-reviewed scientific methods; and is fully repeatable.

What is Unique about LANDFIRE?

Addresses fire management needs:

- Firefighting operations support and safety
- Proactive planning for fuels treatment at landscape scales
- Provides consistent data and tools for assessing risk
- Science based assessment of departure from historical fire regimes

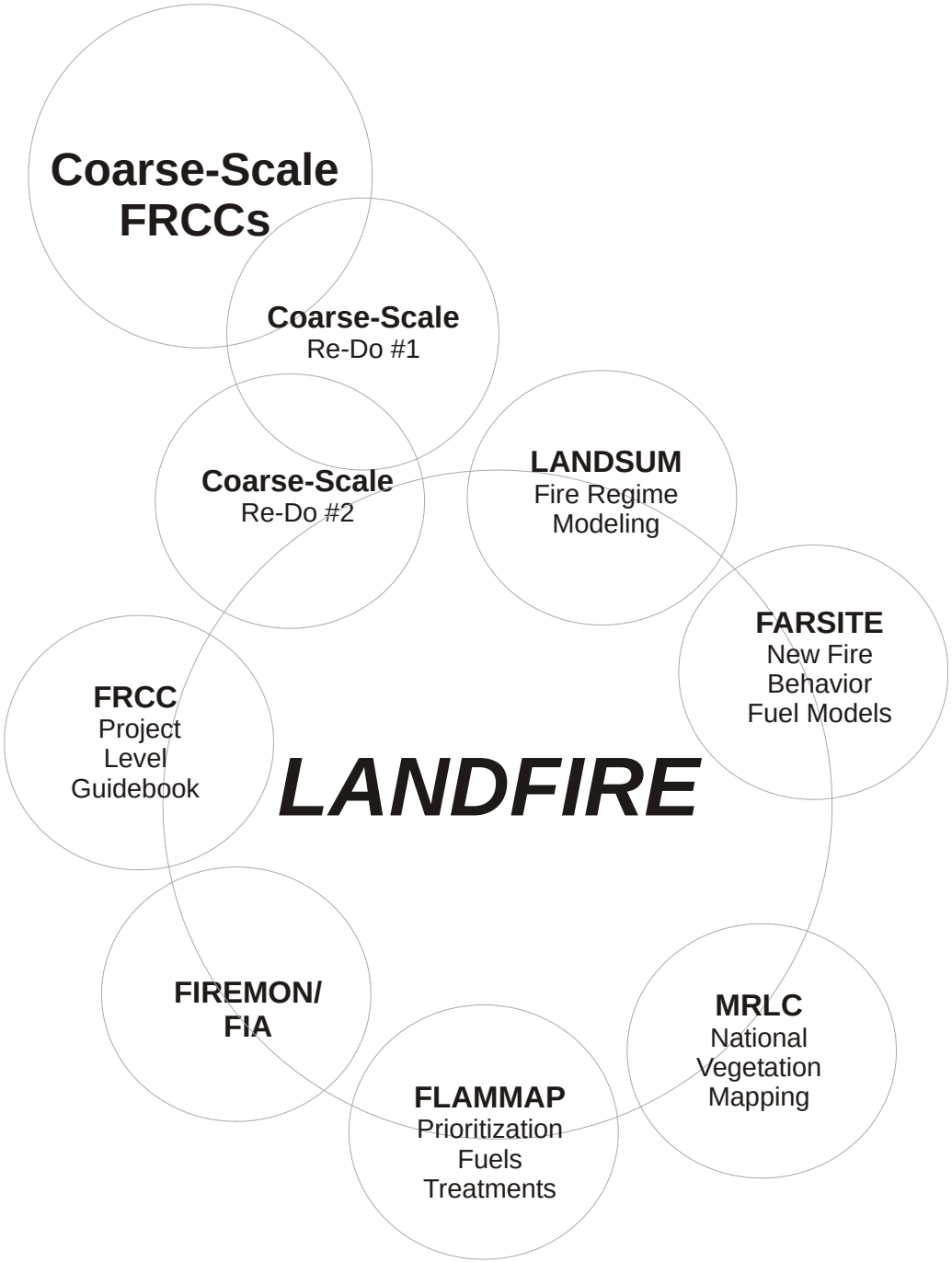
Uses most current mapping technologies

Uses latest ecological simulation approaches

National scale, fine grain

Multiple natural resources applications

Open source; methods, data, and tools available to all

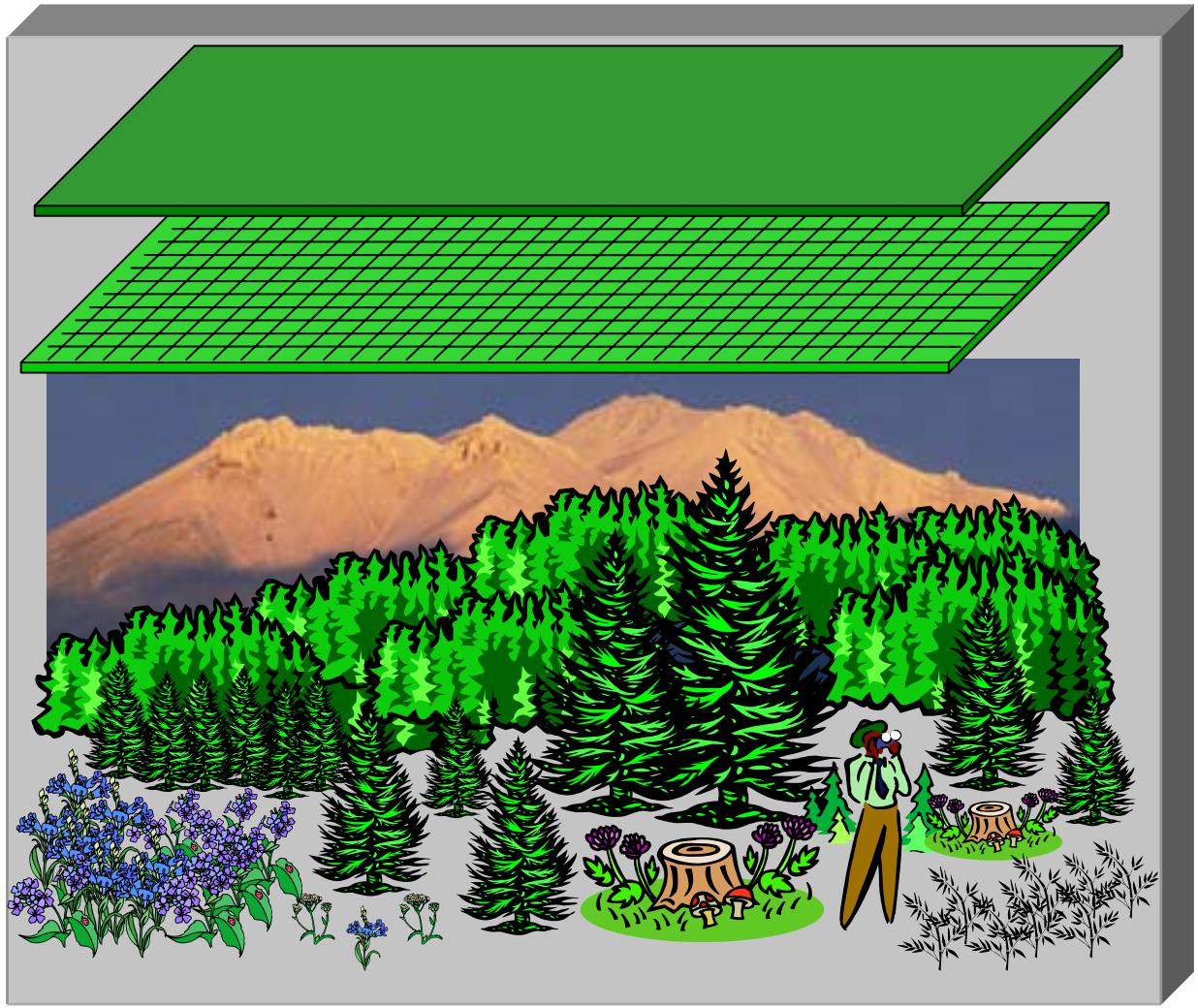

Coarse-Scale FRCCs
Coarse-Scale Re-Do #1
Coarse-Scale Re-Do #2
LANDSUM Fire Regime Modeling
FARSITE New Fire Behavior Fuel Models
FRCC Project Level Guidebook
LANDFIRE
FIREMON/ FIA
MRLC National Vegetation Mapping
FLAMMAP Prioritization Fuels Treatments

Scale is Important

Coarse scale

LANDFIRE

Field data



LANDFIRE summary

Maps created at 30-m^2 cell size

- Fine spatial grain, broad extent
- Mid-scale classification design

Ecosystem process-based approach

- Integrate simulated biophysical processes with satellite imagery to map fuel condition, ecosystem status

Quantitative and qualitative validation

- Cross validation of all mapped deliverables
- Concentrate on products that will provide manager tools they need to describe fuel condition on their landscape

LANDFIRE Products

- **Historical natural fire regimes**
- **Fire regime condition classes**
- **Fuels, FARSITE input data layers**
- Climate and weather (DAYMET)
- A suite of 100+ environmental gradient layers
- **Comprehensive field reference database**
- Potential vegetation types
- Actual vegetation types
- Actual vegetation canopy height
- Actual vegetation canopy density
- Vegetation and habitat conditions
- Biophysical settings
- Mapped soil attributes
- Succession pathways
- LF-BGC model
- LANDSUM model
- WXFIRE model
- **FIREHARM model**
- Potential fire behavior fuel models
- Fuels loading models
- Crown fuel models
- Repeatability, adaptability
- Peer-reviewed science
- WUI, topography, infrastructure, seamless distribution, and watershed analysis capabilities via USGS *the National Map* research

Broad Partnership

Government

Non-Government

Databases

- Forest Service
- USGS
- Other federal agencies
- USGS On-site Contractor
- Private contractor
- NGO
- Universities

Methods

- USGS
- USFS
- USGS On-site Contractor

Models

- USGS
- Forest Service
- USGS On-site Contractor

Vegetation, fuels, and risk deliverables

- Forest Service
- NGO
- USGS On-site Contractor
- Private contractor
- Private contractor
- Private contractor

Tech transfer & distribution

- Private sector e.g., TNC, ESRI technology
- Forest Service
- USGS

Five-year repeat cycle

- Private sector

LANDFIRE Prototype

Three-year prototype funding

March 2002 – February 2005

The technical team has completed almost two years of work

We anticipate completing the prototype map zones within FY04

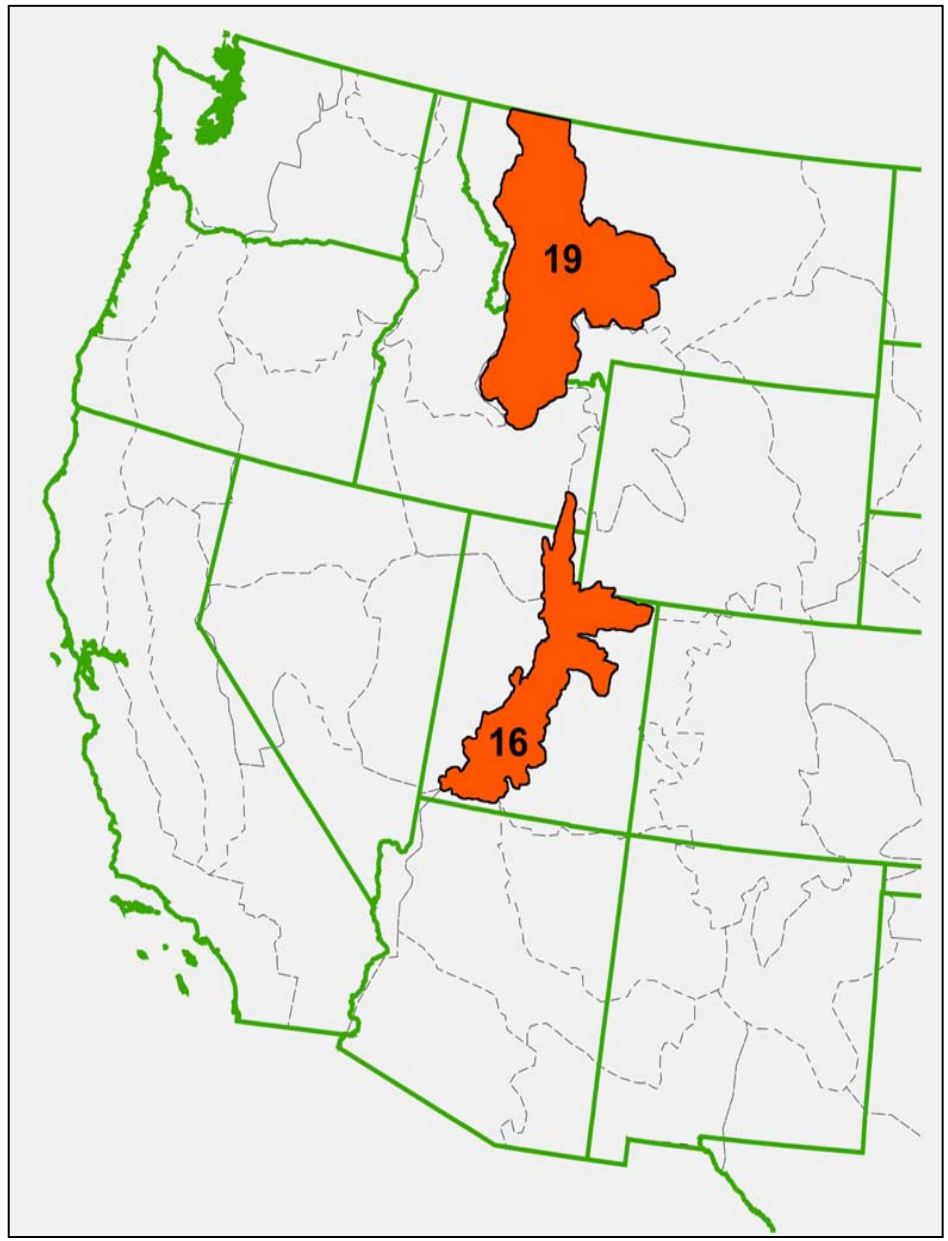
LANDFIRE Prototype Areas

Central Utah

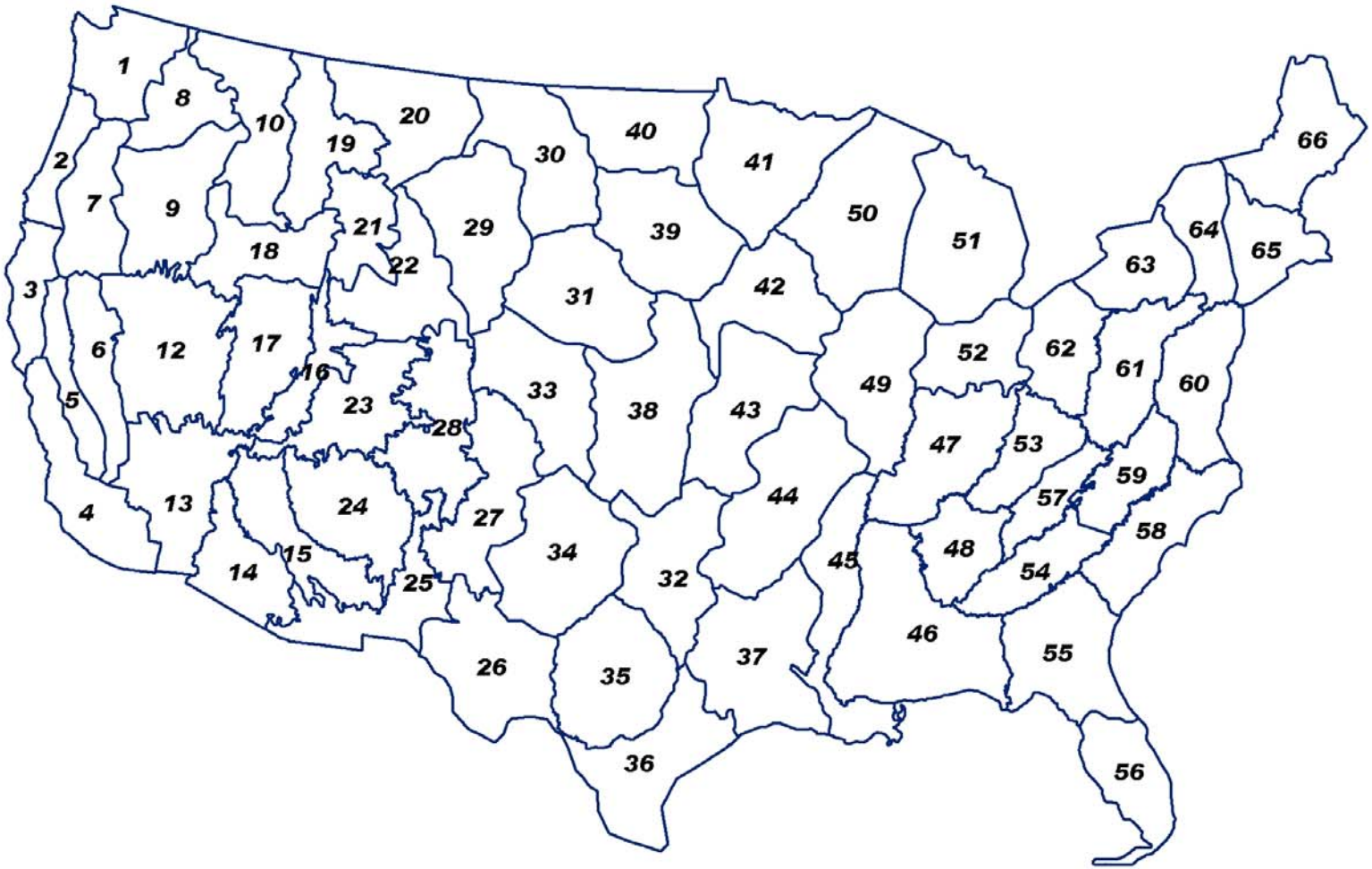
Over 7 million hectares with 55% forested and 45% non-forested lands.

NW Montana/Idaho

10.5 million hectares with 65% forested and 35% non-forested lands.

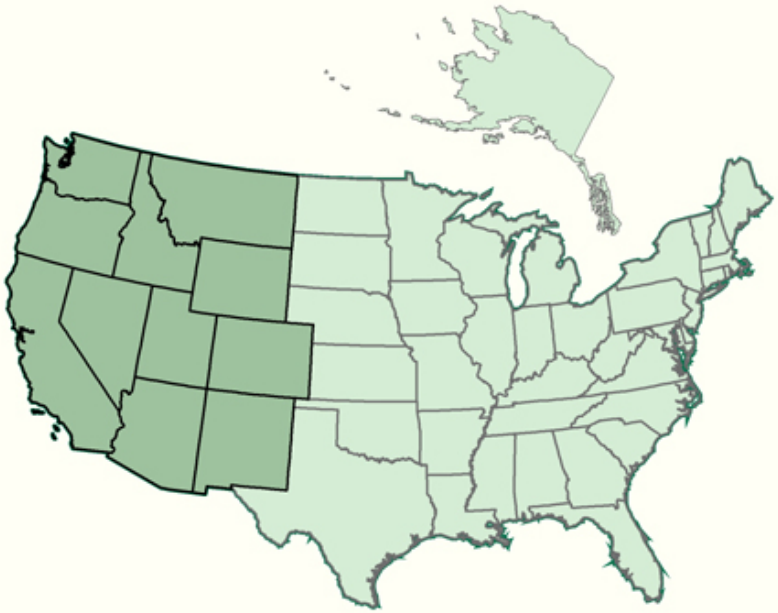


MRLC2000 Map Zones
Order of Map zones for LANDFIRE yet to be determined



Five-Year Timeline

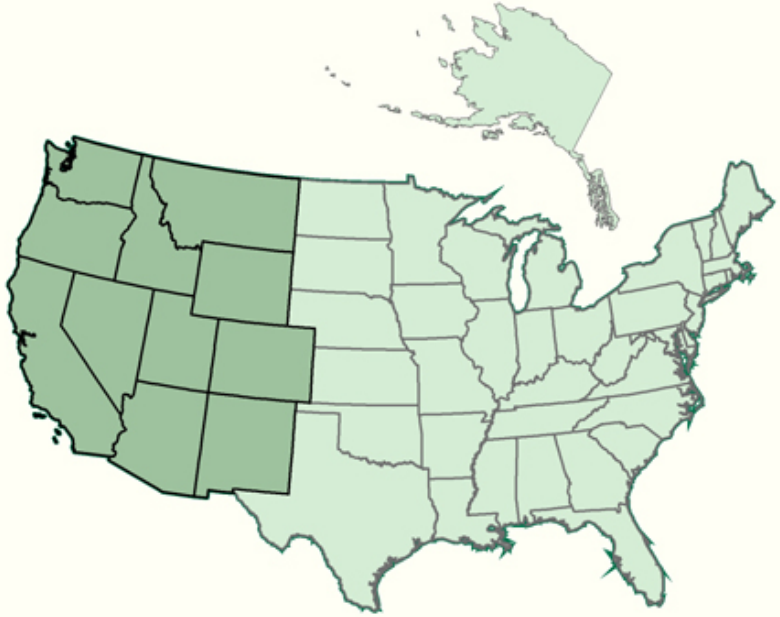
Rapid Assessment



Rapid Assessment Progress and Timeline

Fiscal Year	2003	2004	2005	2006	2007	2008
Western US						
Eastern US and Alaska						

LANDFIRE



LANDFIRE Progress and Timeline

Fiscal Year	2003	2004	2005	2006	2007	2008
Western US						
Eastern US and Alaska						

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USGS

Geography - *The National Map*

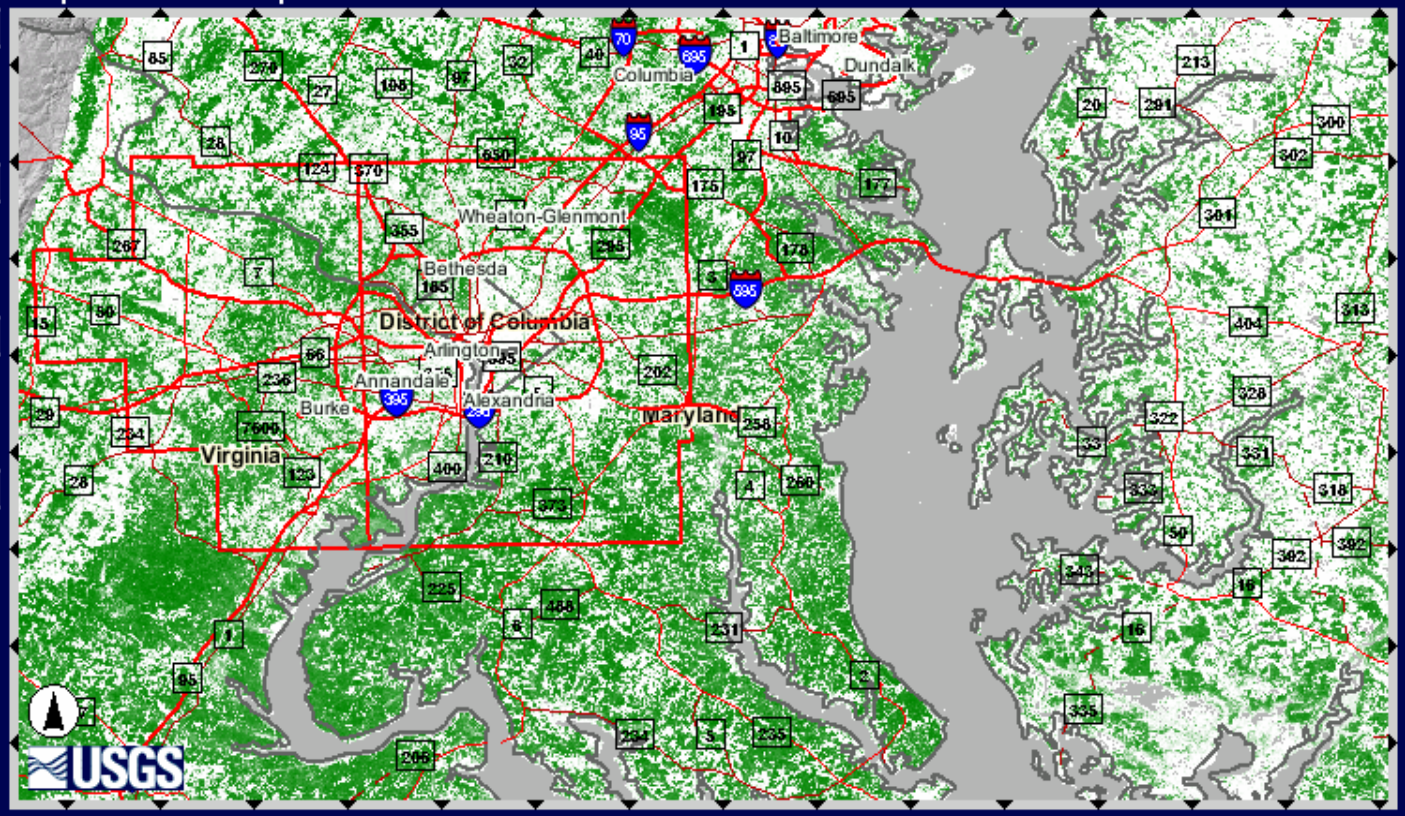
The National Map GISDATA Map Studio

Zoom

Query

Tools

Docs



Scale Information

Out

Scale ~ 1:1,107,016

Layers

- Names
- Structures
- Transportation
- Boundaries
- Hydrography
- Orthoimagery
- Land Cover
  - USGS National Lan Cover Database 2001 (TEST)
  - USGS NLCD 2001 Percent Imperviou Surface (TEST)
  - ☑ USGS NLCD 2001 Percent Canopy Density (TEST)
  - USGS NLCD
  - USGS NLCD Transparent on NE Shaded Relief
  - USGS Current Greenness (NDVI) (TEST)

U.S. Department of the Interior || U.S. Geological Survey || EROS Data Center

URL: http://gisdata.usgs.net/website/Map_Studio/ || Maintainer: webmapping@usgs.gov || Modified: April 15, 2003

Map: -75.83 , 39.3 -- Image: 703 , 11 -- ScaleFactor: 0.002585567271447251

Internet

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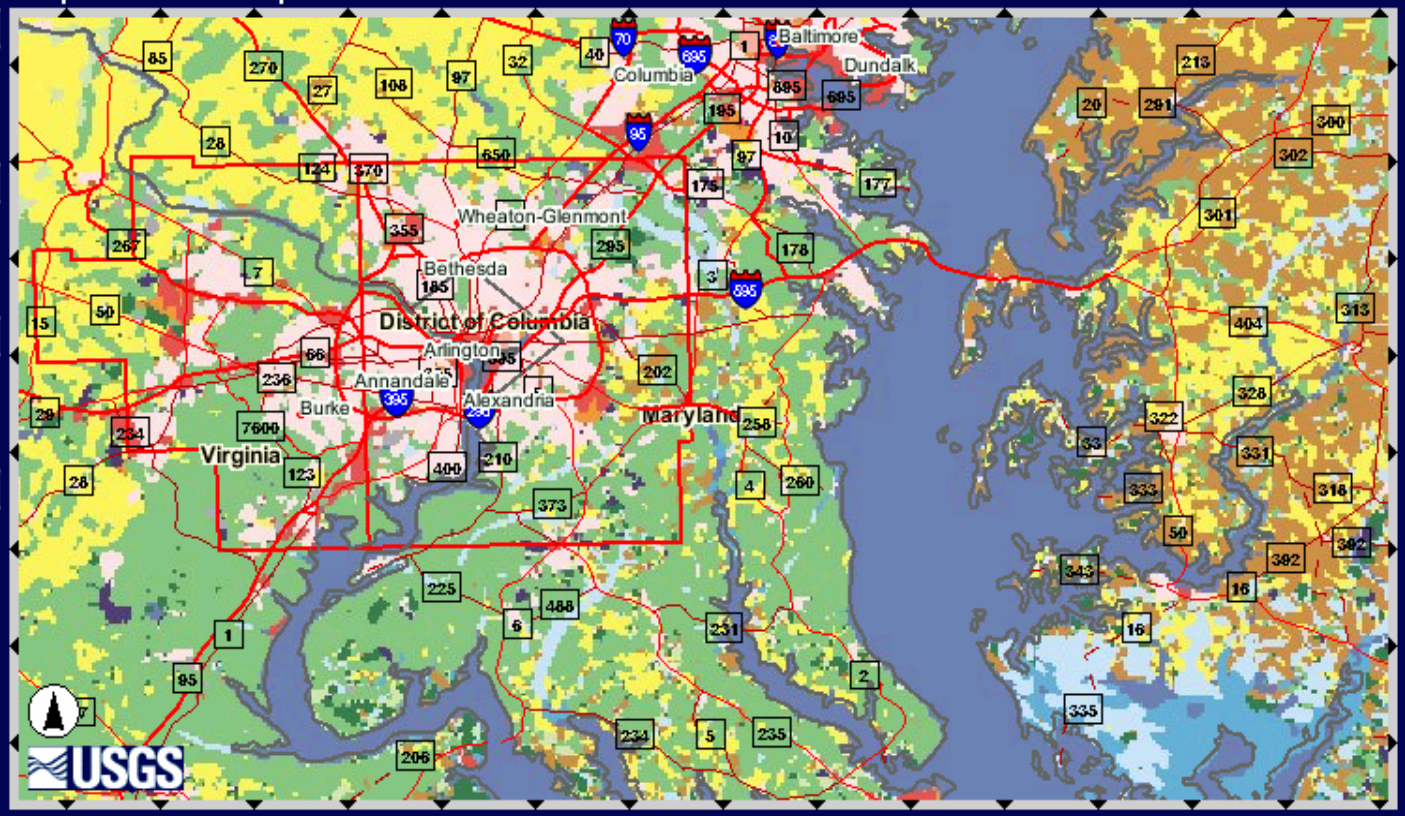

ESRI Roads

Boundaries

Hydrography

Orthoimagery

Land Cover

- USGS National Land Cover Database 2001 (TEST)
- USGS NLCD 2001 Percent Imperviou Surface (TEST)
- USGS NLCD 2001 Percent Canopy Density (TEST)
- ☑ USGS NLCD
- USGS NLCD Transparent on NE Shaded Relief
- USGS Current Greenness (NDVI) (TEST)
- USGS Current Fire Potential Index (TEST)
- ESRI Vegetation Zones
- WWF Biological Distinctiveness

Elevation

NED Shaded Relief

U.S. Department of the Interior || U.S. Geological Survey || EROS Data Center

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USGS

Geography - *The National Map*

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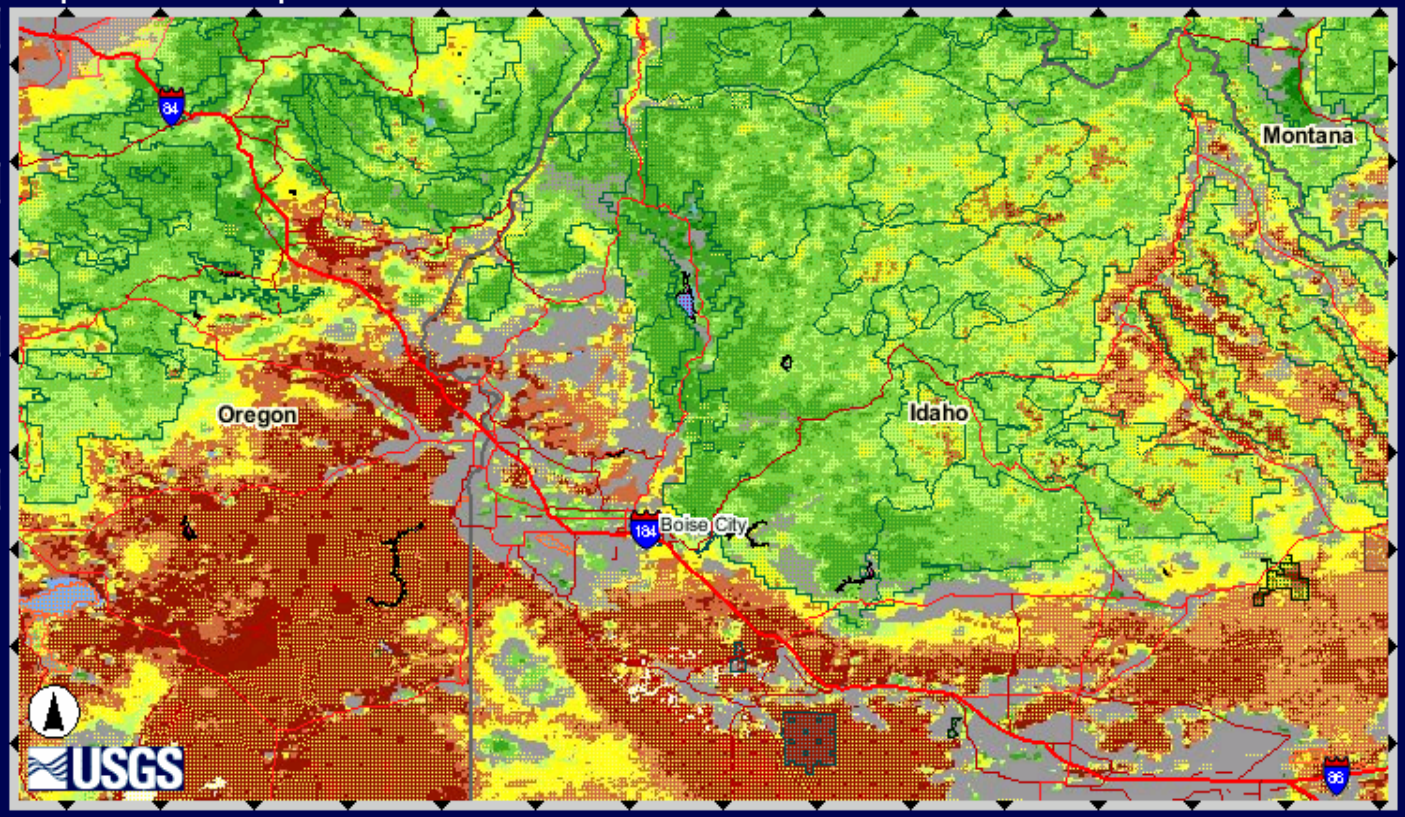

Scale Information

Out

Scale ~ 1:3,456,615

Layers

Names

Structures

No Layers available in this category

Transportation

- [x] National Atlas and ESRI Roads

Boundaries

- [x] National Atlas and USGS State Boundaries
- [ ] USGS County Boundaries
- [x] National Atlas Federal Lands
- [ ] USGS Urban Areas
- [ ] ESRI Country Boundaries
- [ ] ESRI Boundary Lines

Hydrography

- [ ] USGS NHD Water Bodies
- [ ] National Atlas

U.S. Department of the Interior || U.S. Geological Survey || EROS Data Center

URL: http://gisdata.usgs.net/website/Map_Studio/ || Maintainer: webmapping@usgs.gov || Modified: April 15, 2003

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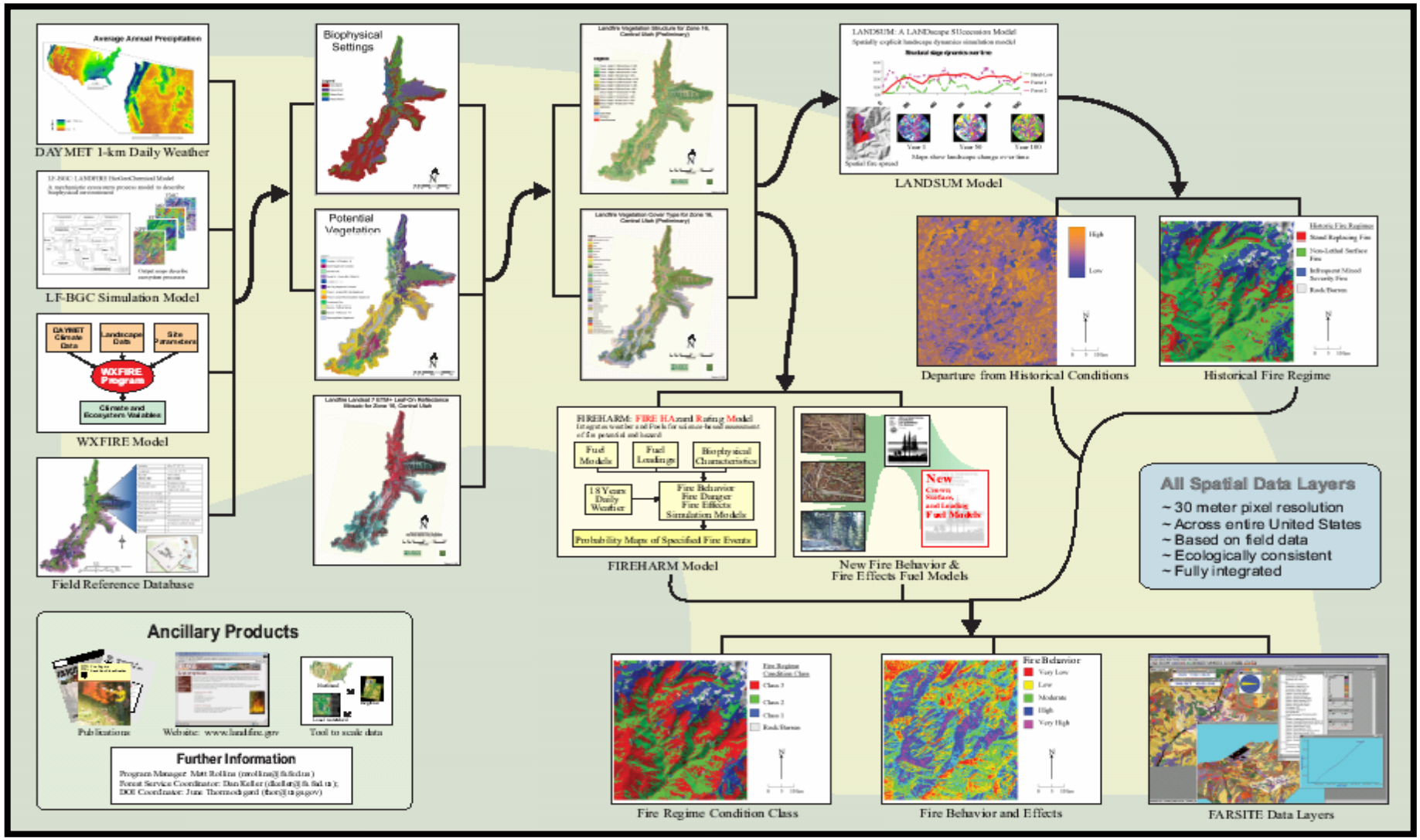
Internet

Methodology



Databases

LANDFIRE
Reference Database
(Plot Data)

- Existing vegetation
- Potential vegetation
- Fuels
- Structure

LANDFIRE
GIS

- Topography/ Edaphic
- Climate
- Ecophysiological

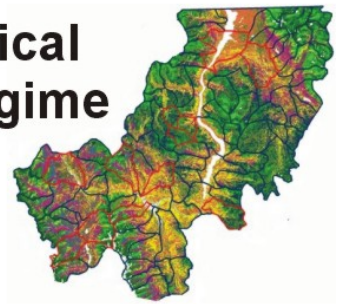
Methods

- Cover Type Classification
- PVT Classification
- Fire behavior models
- Landscape simulation
- CART

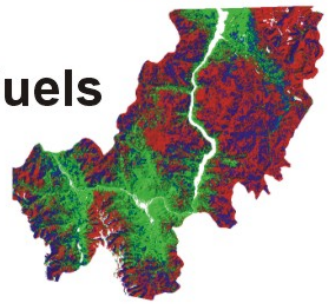
Mapped Deliverables

Fire Danger

Historical Fire Regime



Fuels



Condition Class

Utah Test Area Field Plot Data

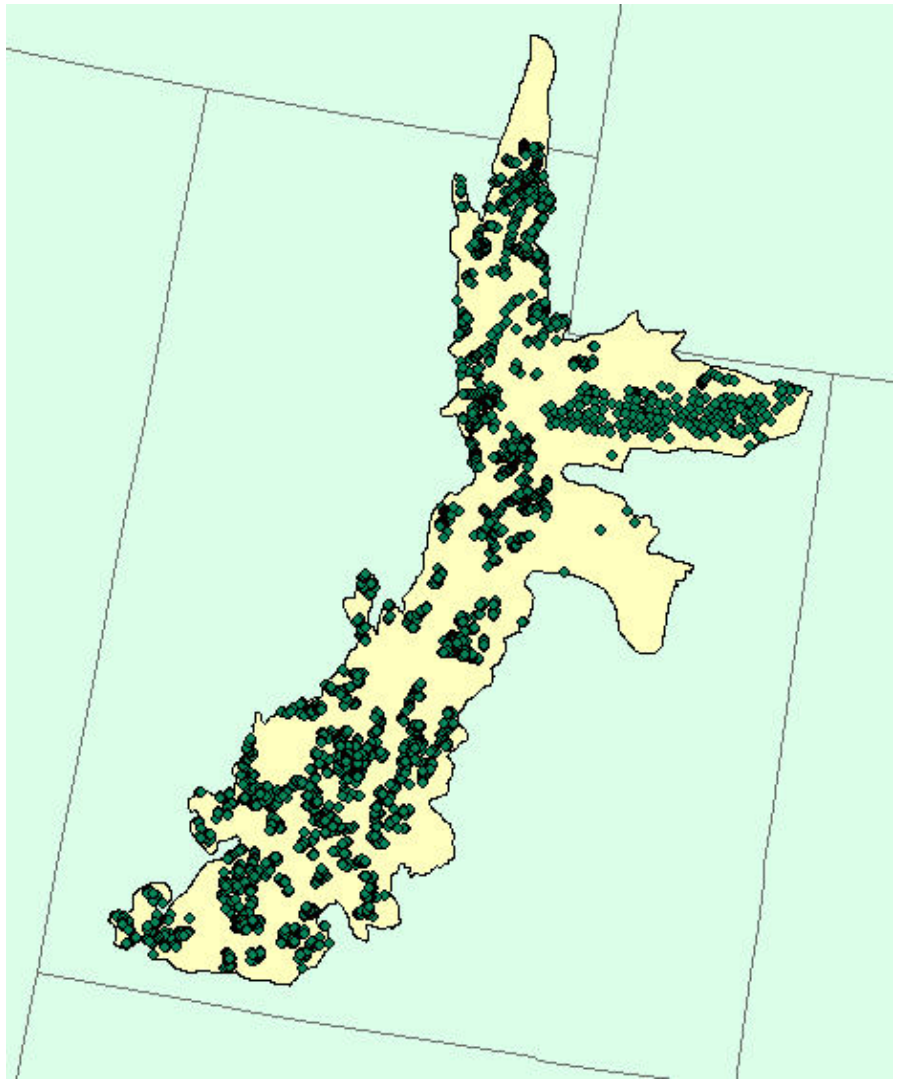
Distribution of Zone 16 Field Plots:

FIA: 2052

FSL: 4158

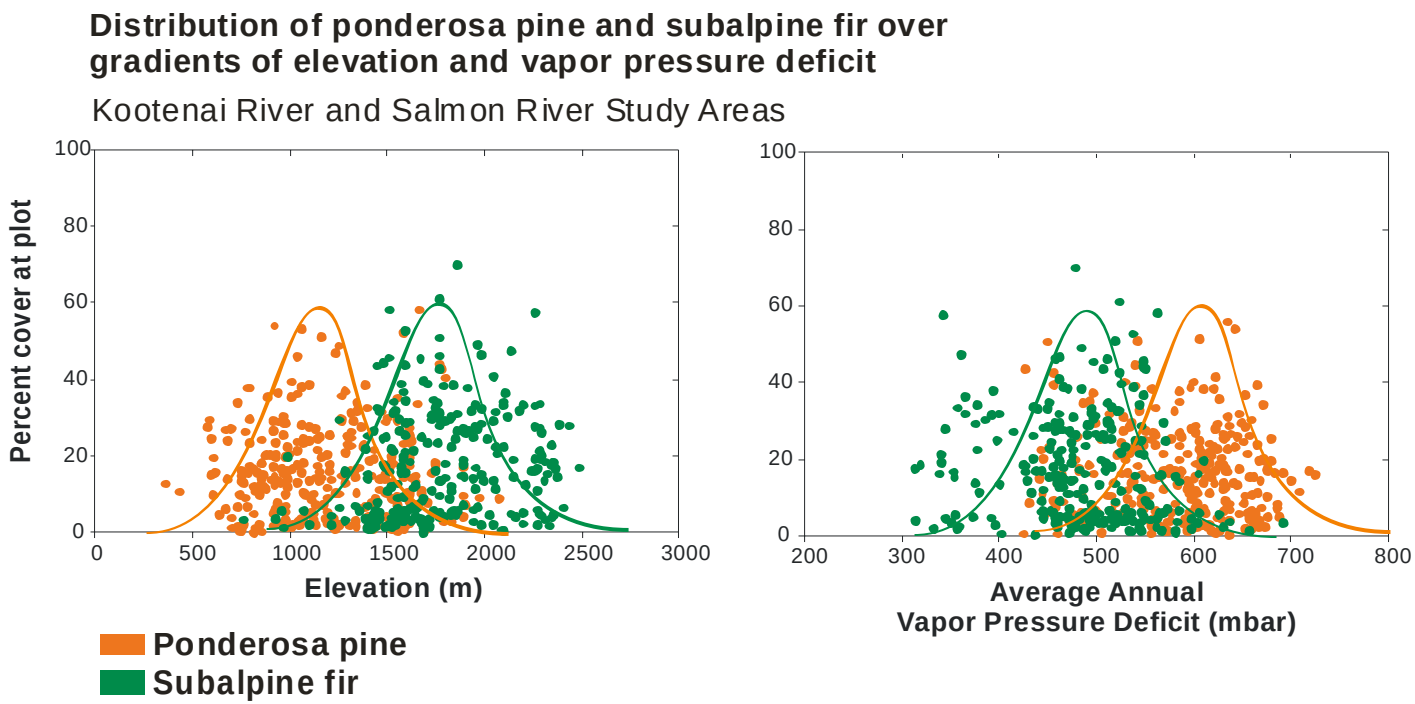
Total: 6210

The number of field plots available to LANDFIRE is significantly higher than any other similar efforts



LANDFIRE Biophysical Settings

Mapped biophysical settings describe important ecological gradients that determine landscape composition, structure, and function



Gradient (Biophysical Setting) Layers

Climate

Temperature, precipitation

Solar radiation

Annual evapotranspiration

Fire ecology

Fuel moisture stress

Moisture content of fuels

Topography

DEM, slope, aspect

Shade index

Biogeochemical

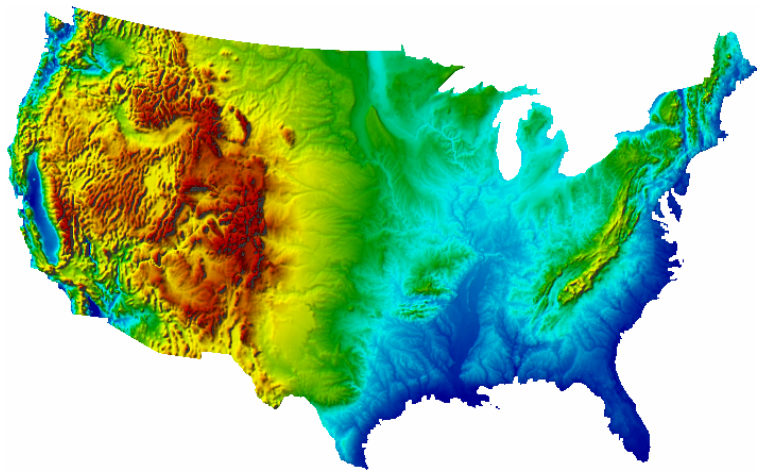
NPP, LAI, PET, AET

Photosynthetic active radiation

Soil

Soil depth, soil moisture

Total carbon in soil



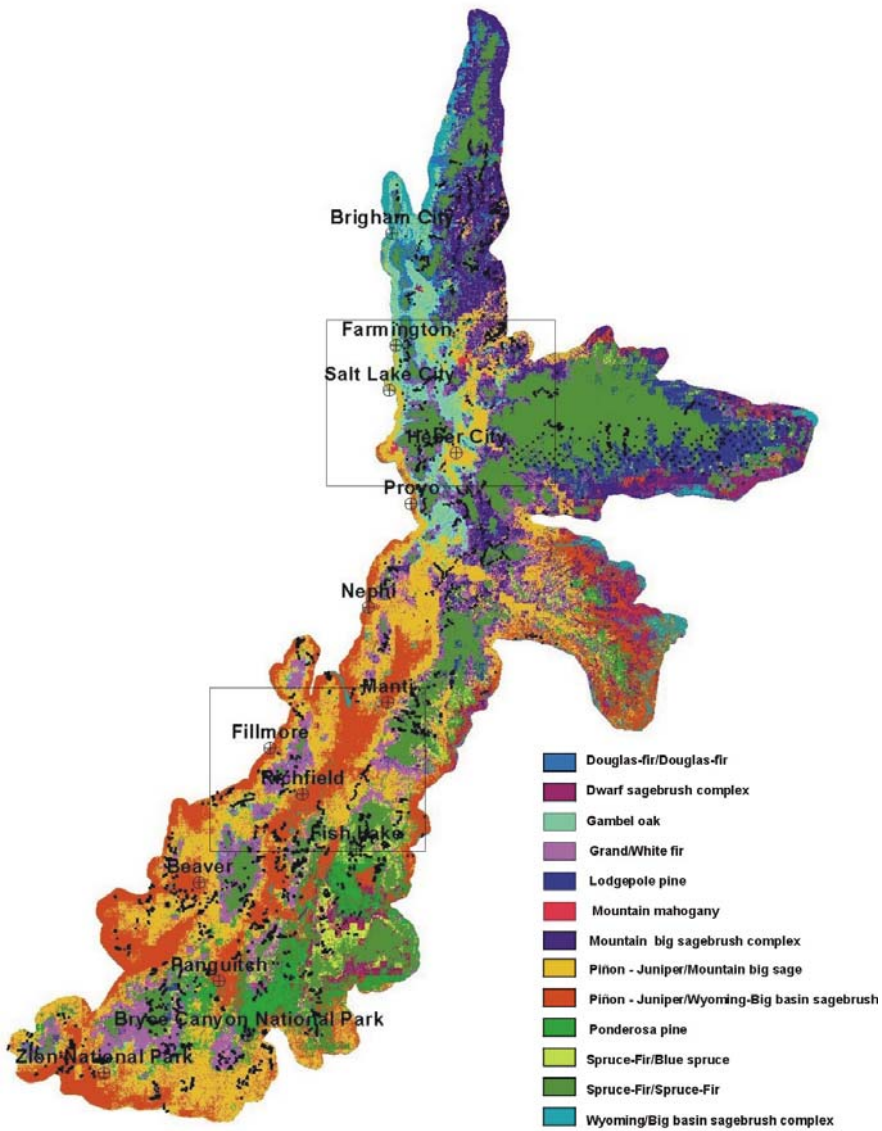
Example of PVT Modeling Run

Input Variables

Field plot data
DAYMET (coarse scale)
PCA
ENPP
DOutflow
GTotalC
Transpiration
SWFraction
Plan_Curve
Soil depth
Elevation
Tmax_Scaled
PPT_Scaled

Accuracy

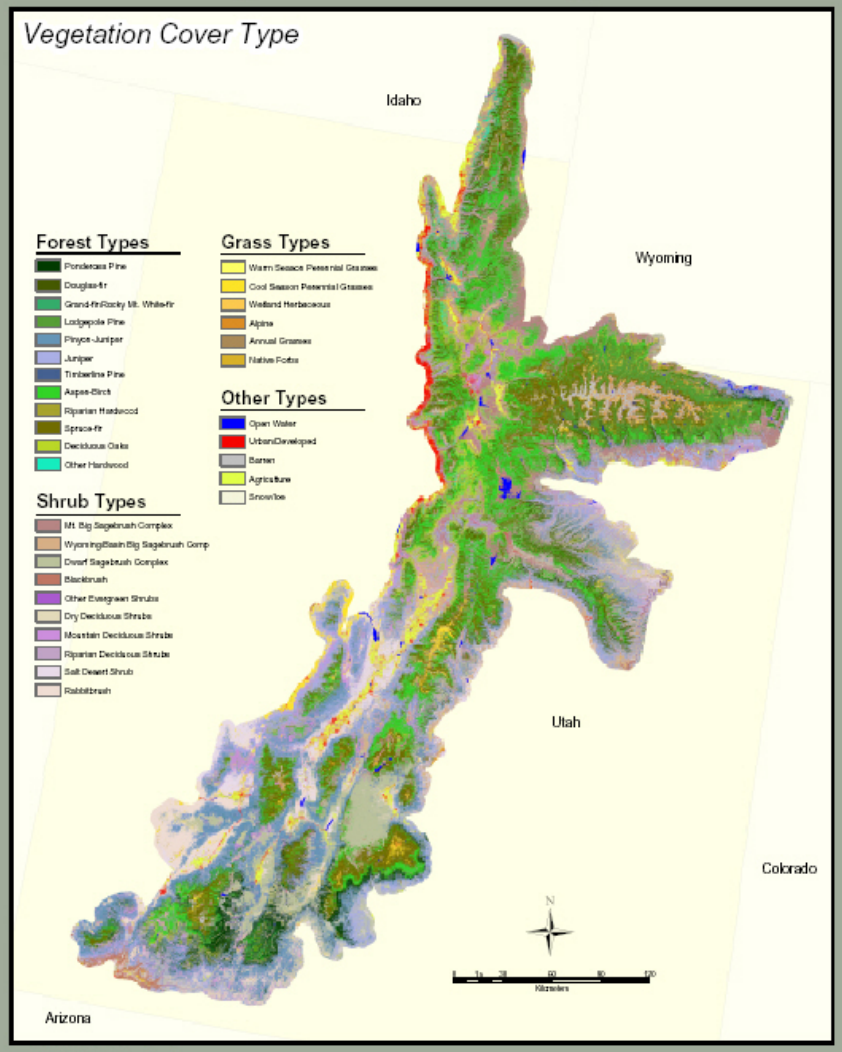
64% (Khat = 0.52)



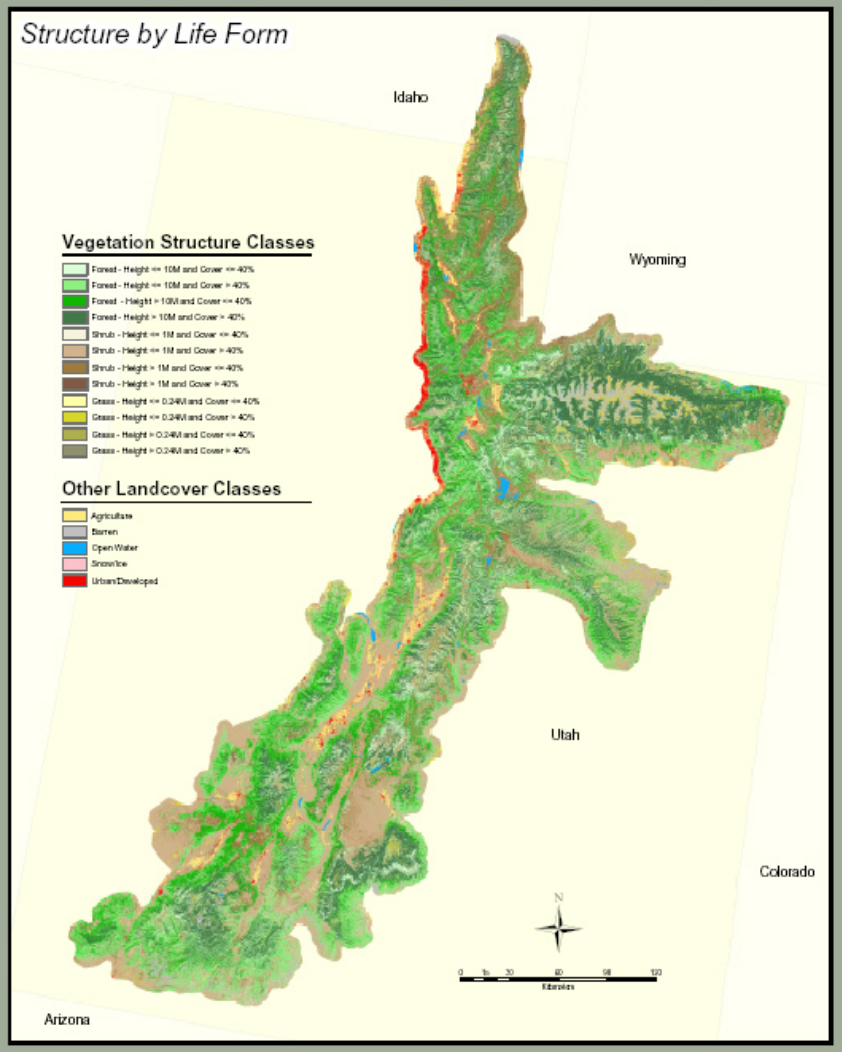
Vegetation mapping results

U.S. Department of the Interior
U.S. Geological Survey

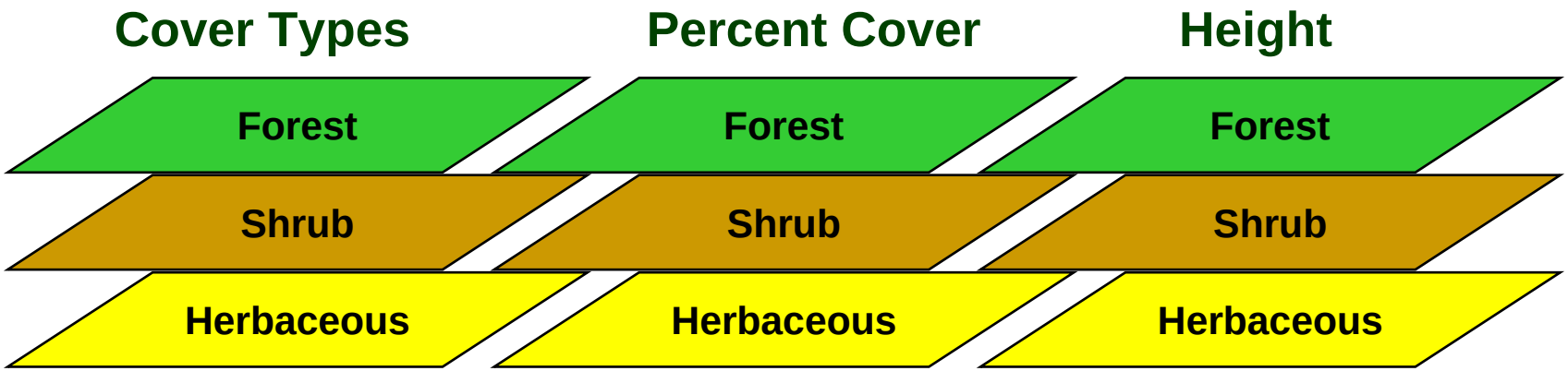
Landfire Vegetation Cover Type and Structure for Mapping Zone 16 (Central Utah)



Preliminary Results
as of February 18, 2003

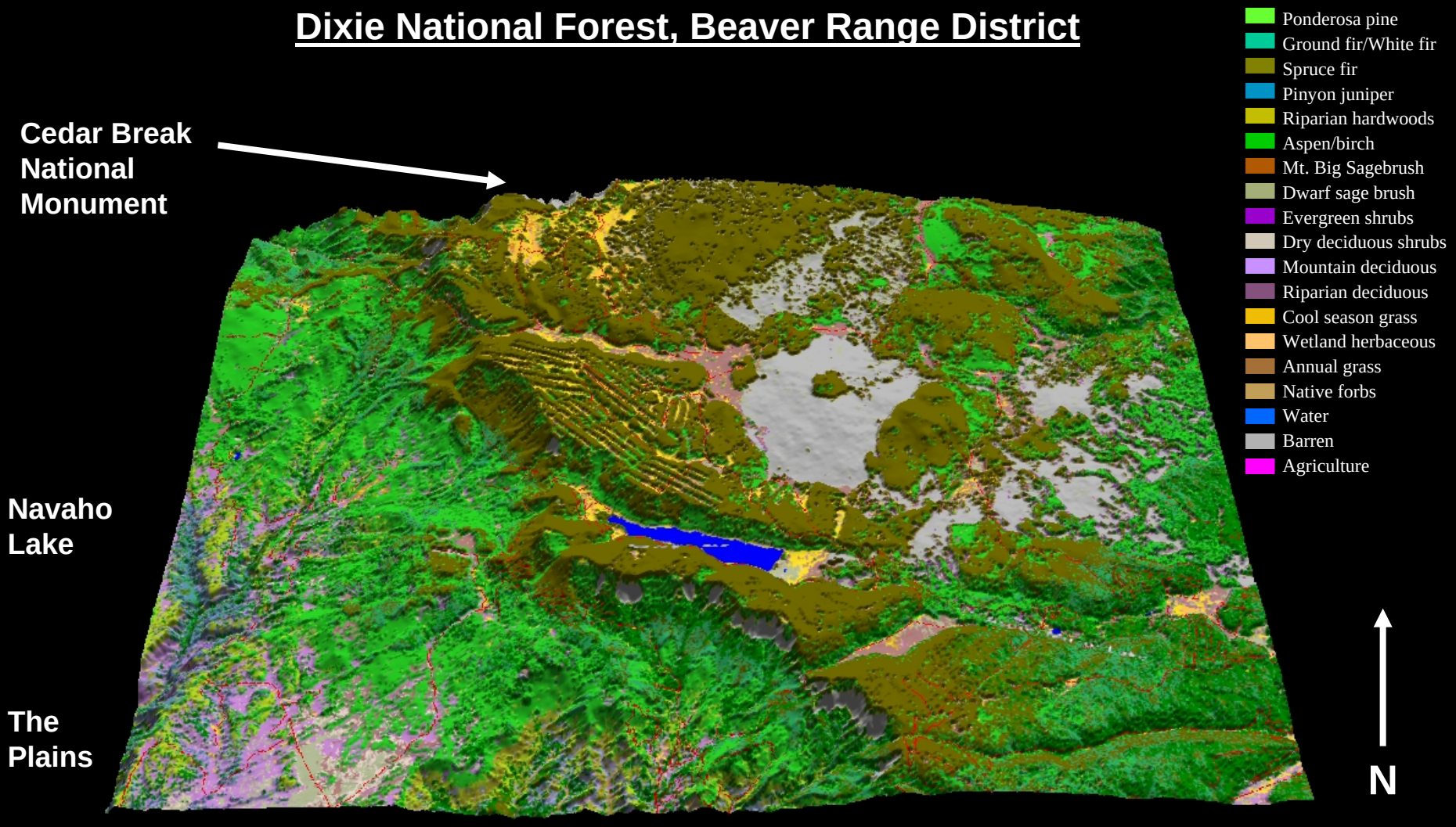


Breaking Landscape Down to 9 Elements



Vegetation Types + Structure

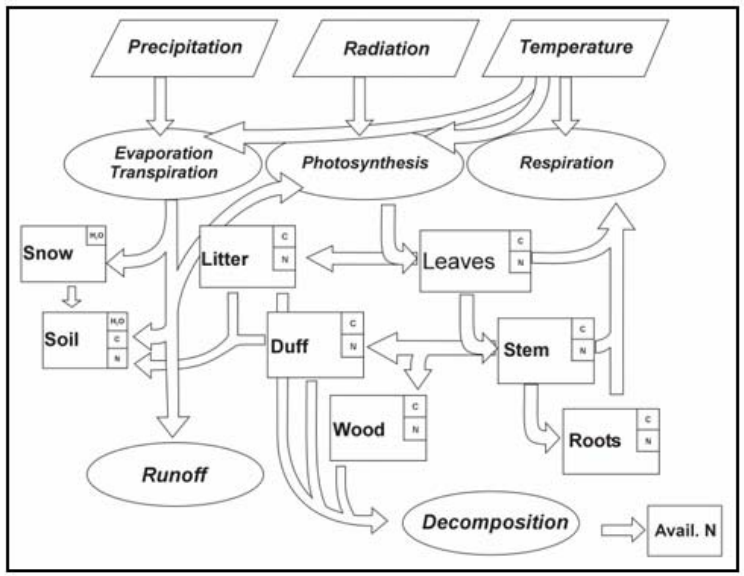
Dixie National Forest, Beaver Range District

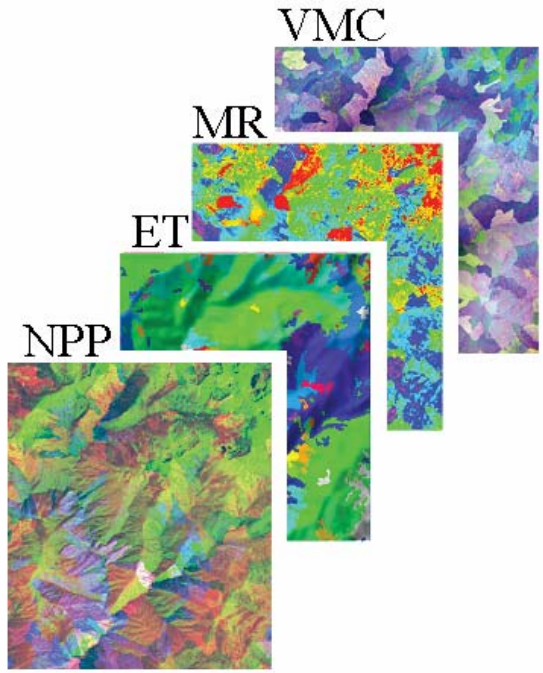


LF-BGC Simulation Model

LF-BGC: LANDFIRE BioGeoChemical Model

A mechanistic ecosystem process model to describe biophysical environment

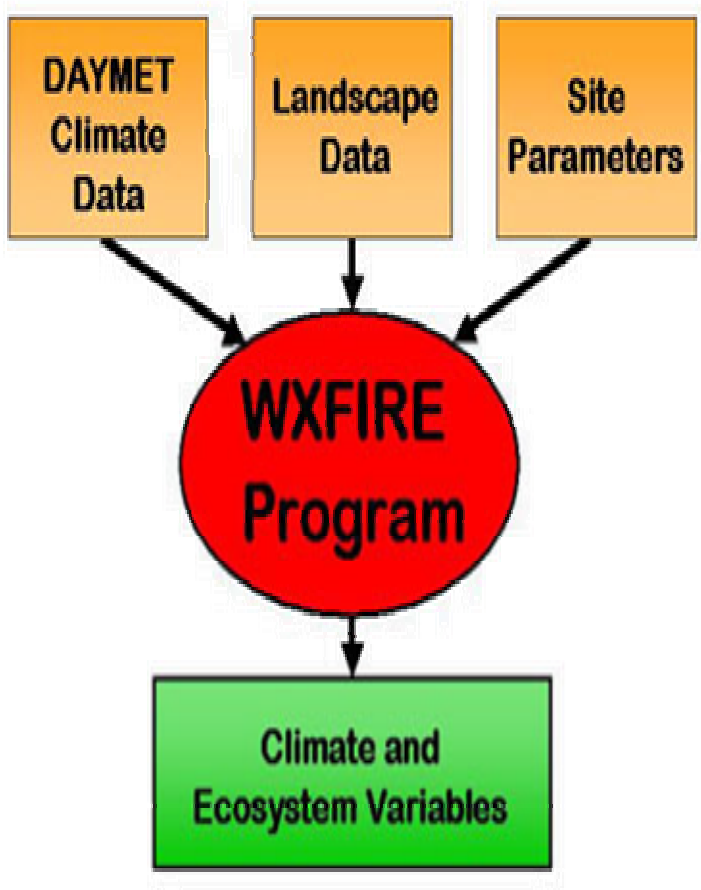




Output maps describe ecosystem processes

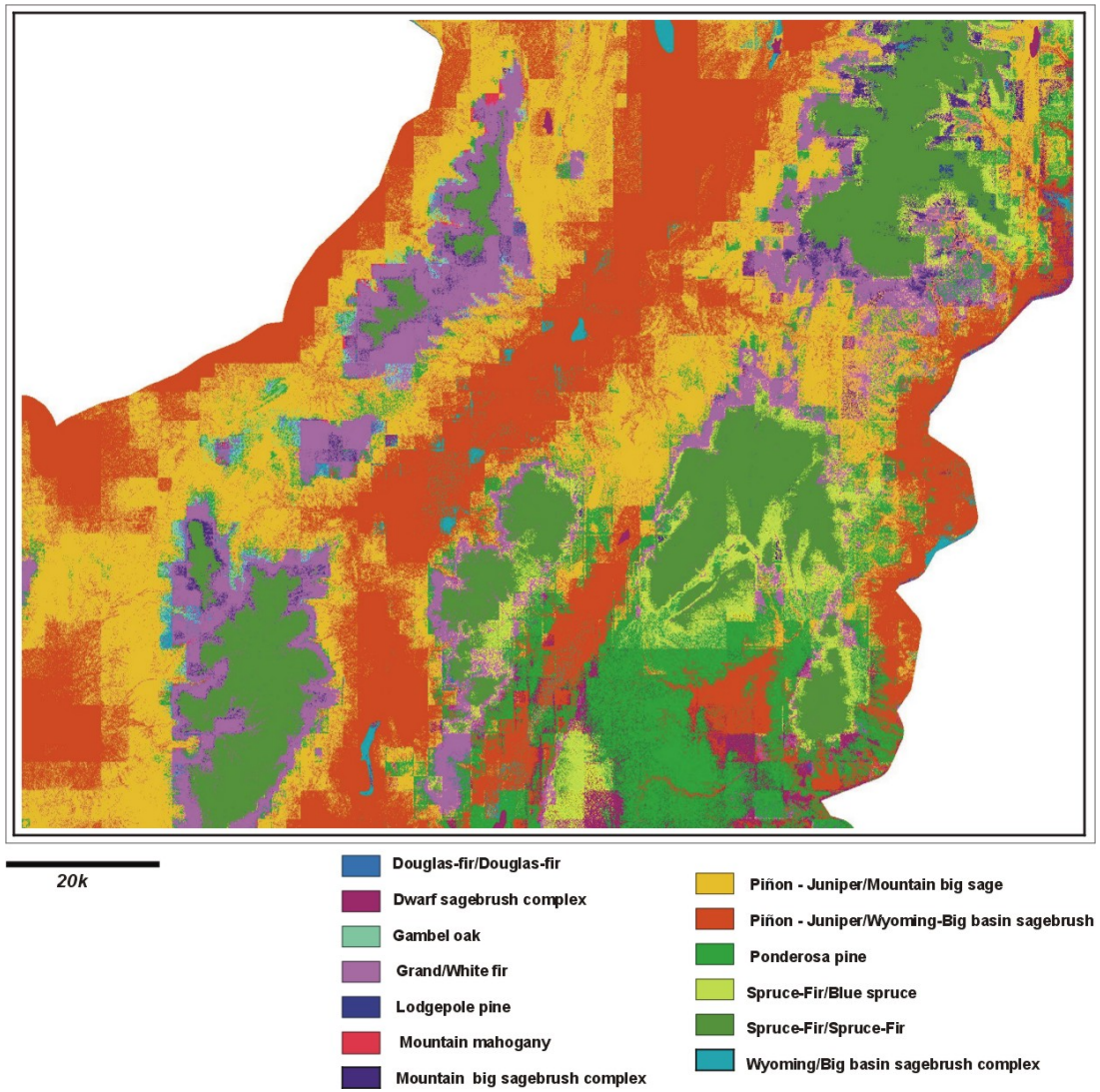
WXFIRE – A weather summarization program

- Calculates annual averages for various weather-related variables (e.g., degree-days)
- Emphasizes variables that integrate biophysical-weather interactions (e.g., PET)
- Scales down 1-Km DAYMET to 30 meters
- Outputs files of annual averages of 58 variables by pixels

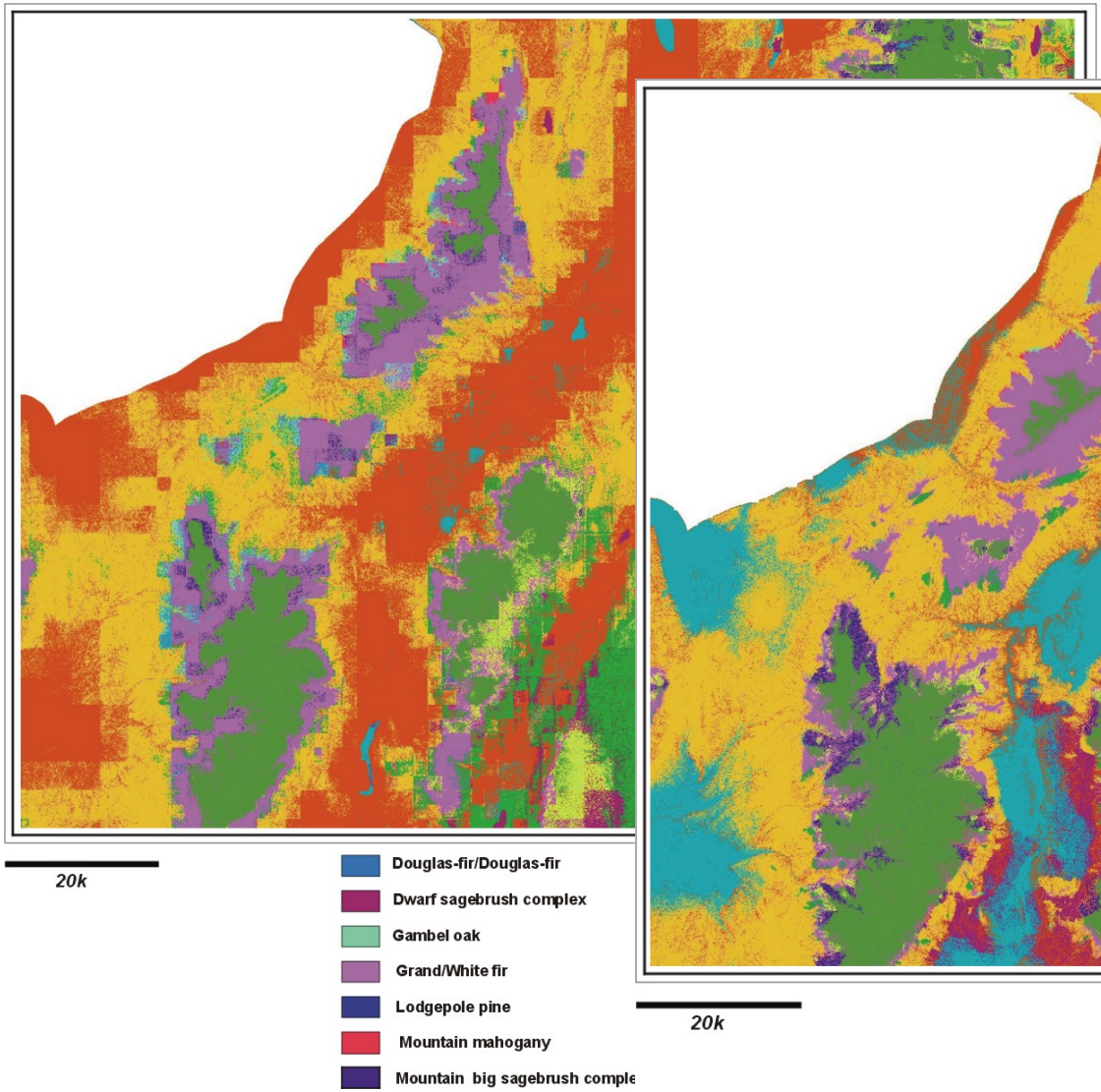


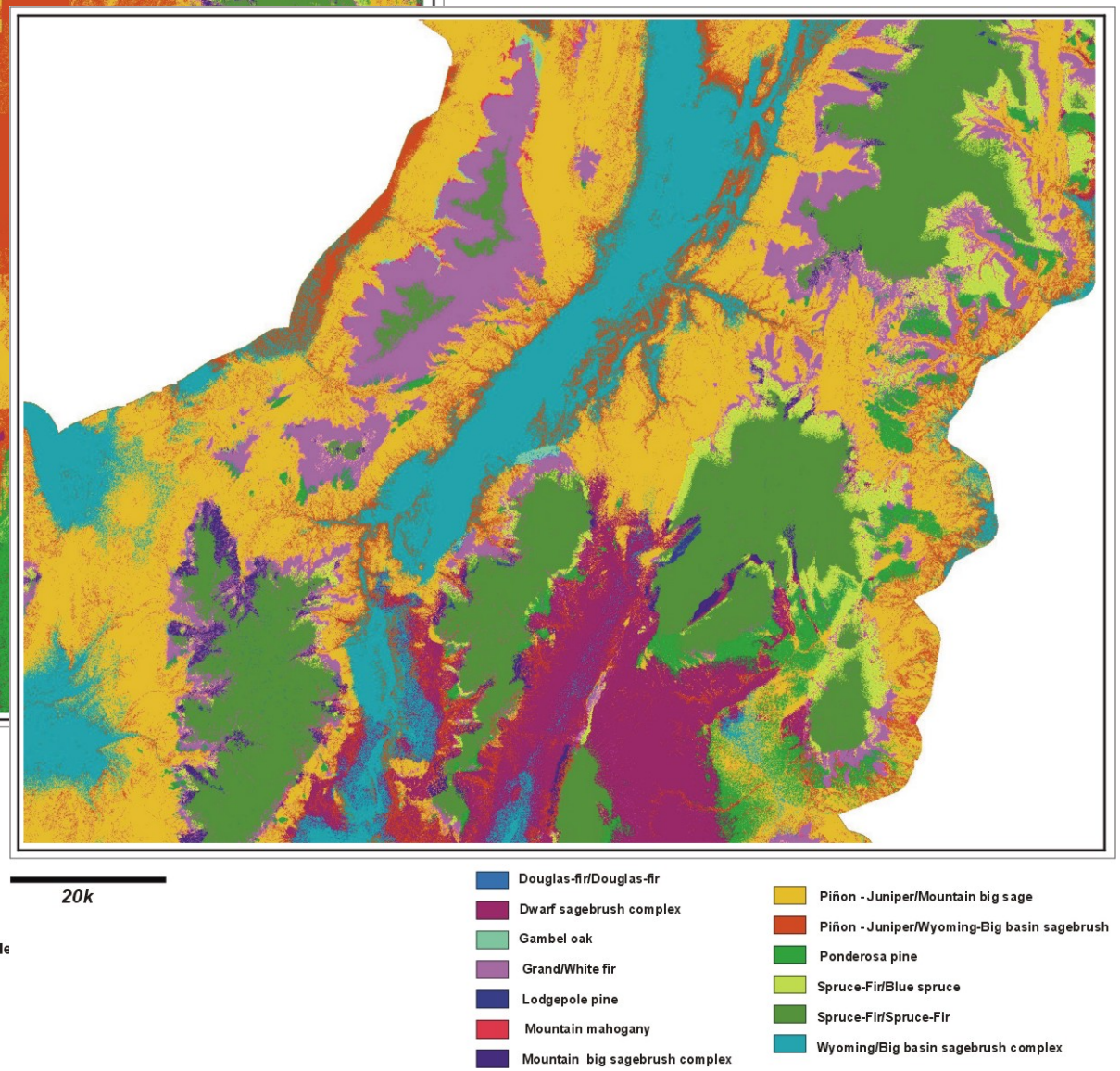
PVT with 1km Footprints

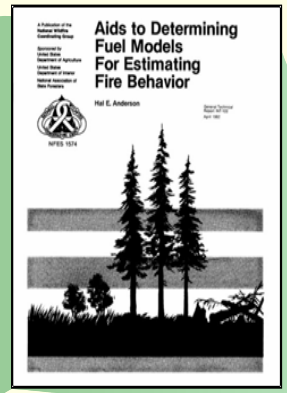
One problem in mapping PVT is 1-km footprints resulting from coarse resolution input data such as DAYMET



Improved Footprint Problem







New

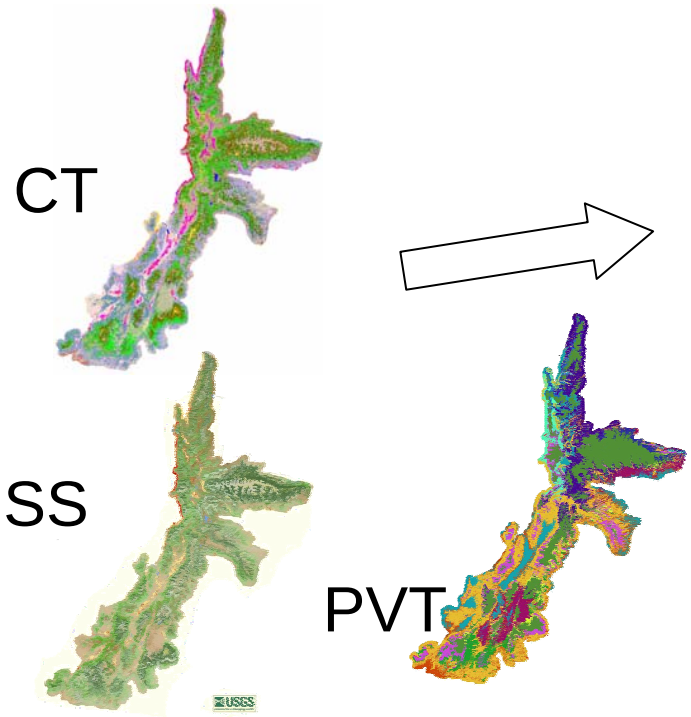
Crown,
Surface,
and Loading
Fuel Models

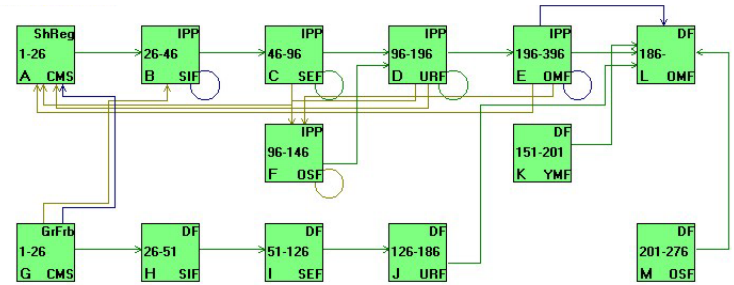
New Fire Behavior & Fire Effects Fuel Models

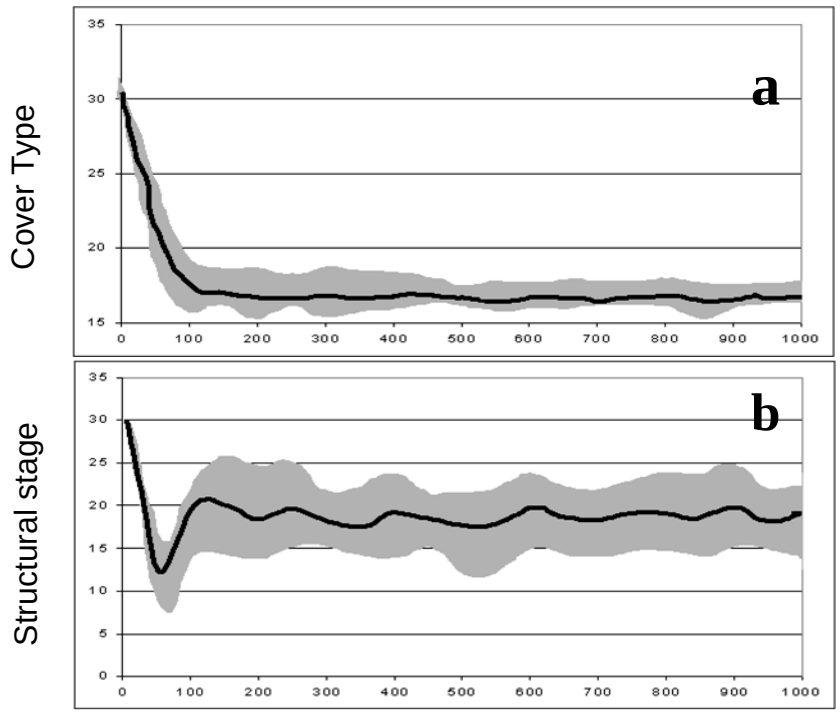
LANDFIRE
Fire Regime Mapping

LANDSUM Landscape Dynamics model

- Cover type, PVT, Structure define ‘states’
- Fire ignition/size modeled statistically
- Fire spread on a pixel-by-pixel basis
- Fire effects variable within burned areas defined by states







LANDSUM Fire Regime Mapping
The ‘short story’

LANDFIRE Fuels Mapping

2 methods:

1. Lookup table:

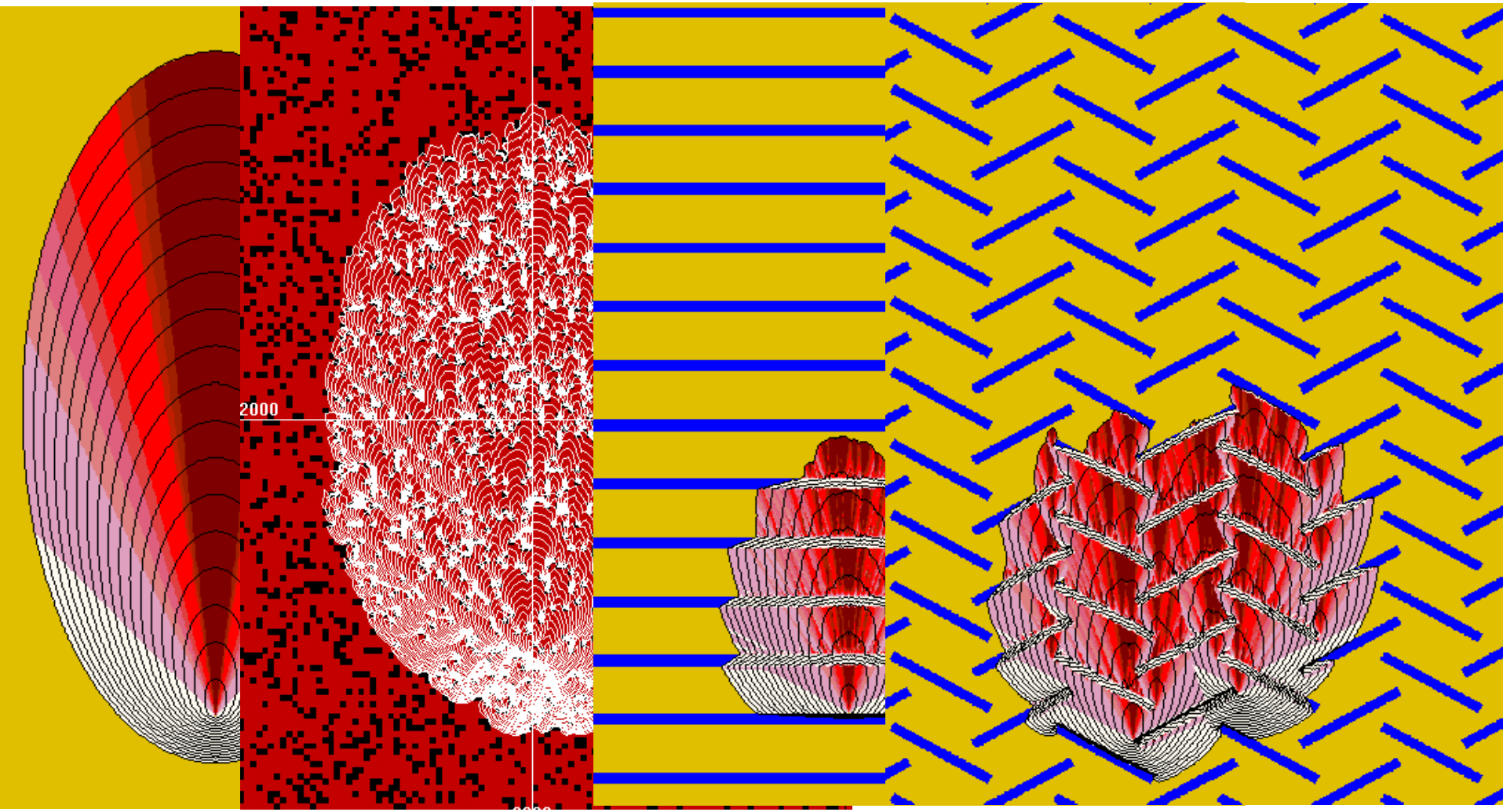
   Permutations of PVT, SS, CT and other geospatial data mapped to fuel model and fuel characteristics

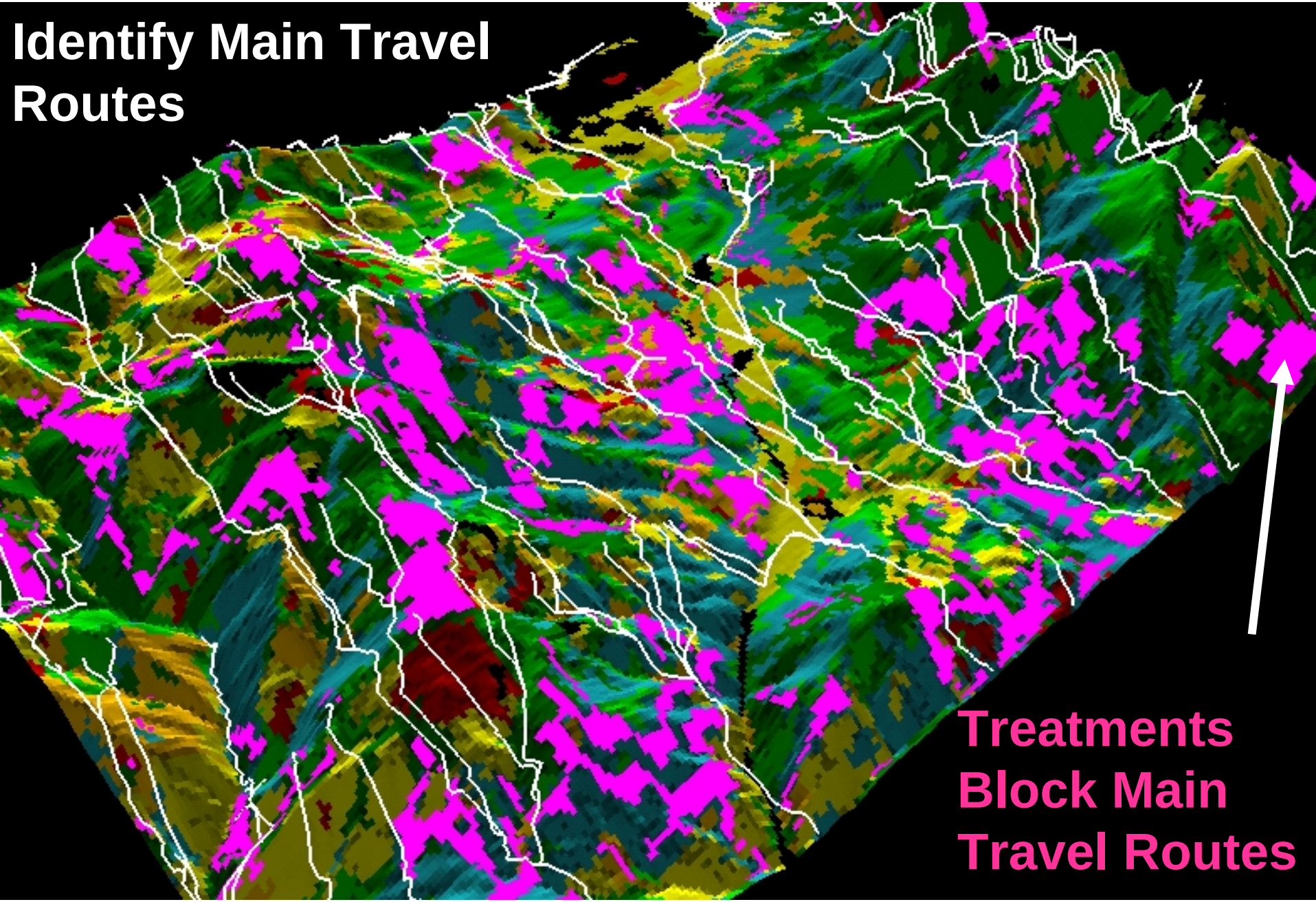
2. Predictive landscape mapping

   Use biophysical settings, remote sensing, and machine learning algorithms to predict fuel model, fuel loads, crown fuels across map zone

~20% treatment

Random | Strips | Strategic



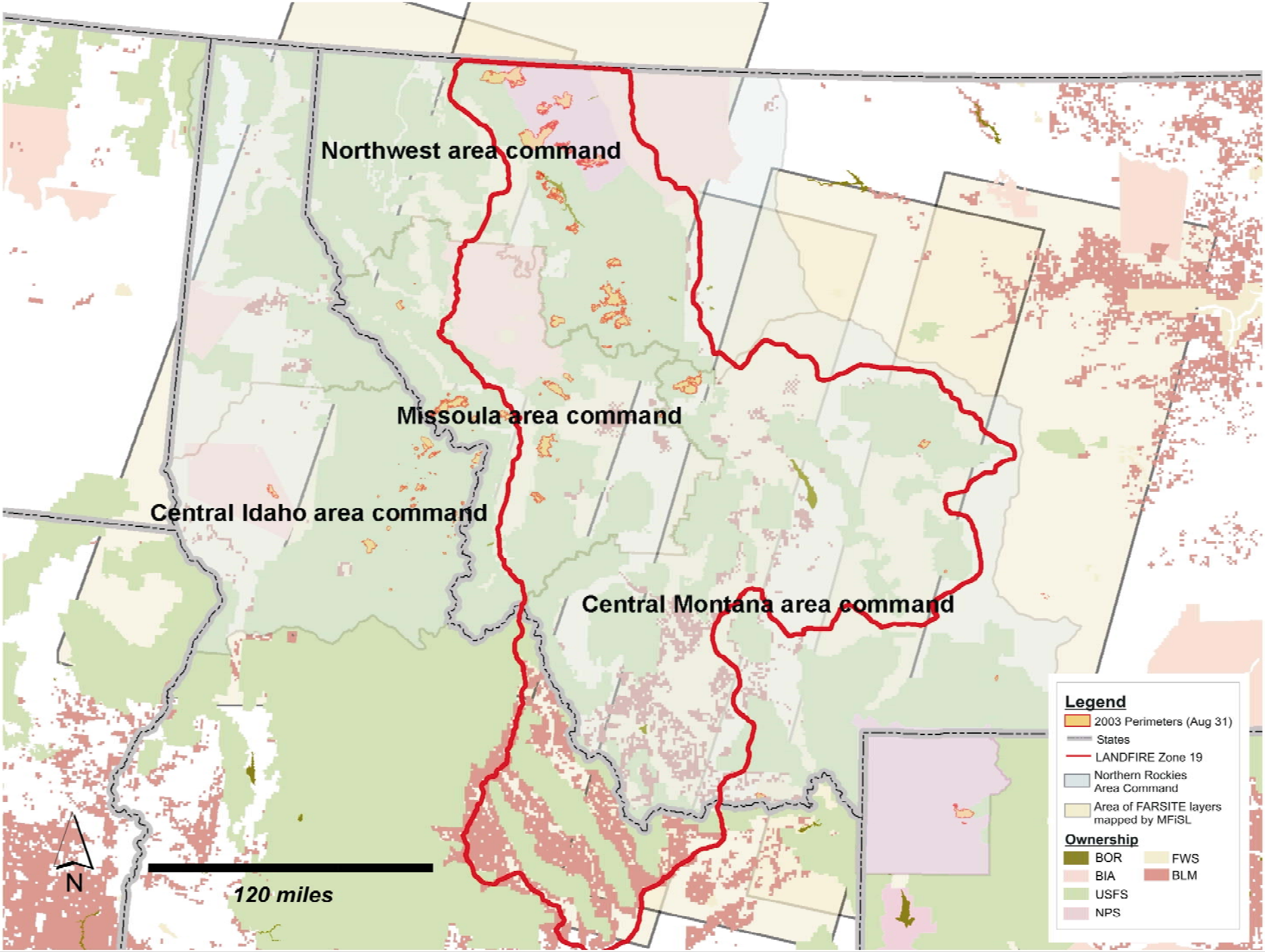

Identify Main Travel Routes
Treatments Block Main Travel Routes

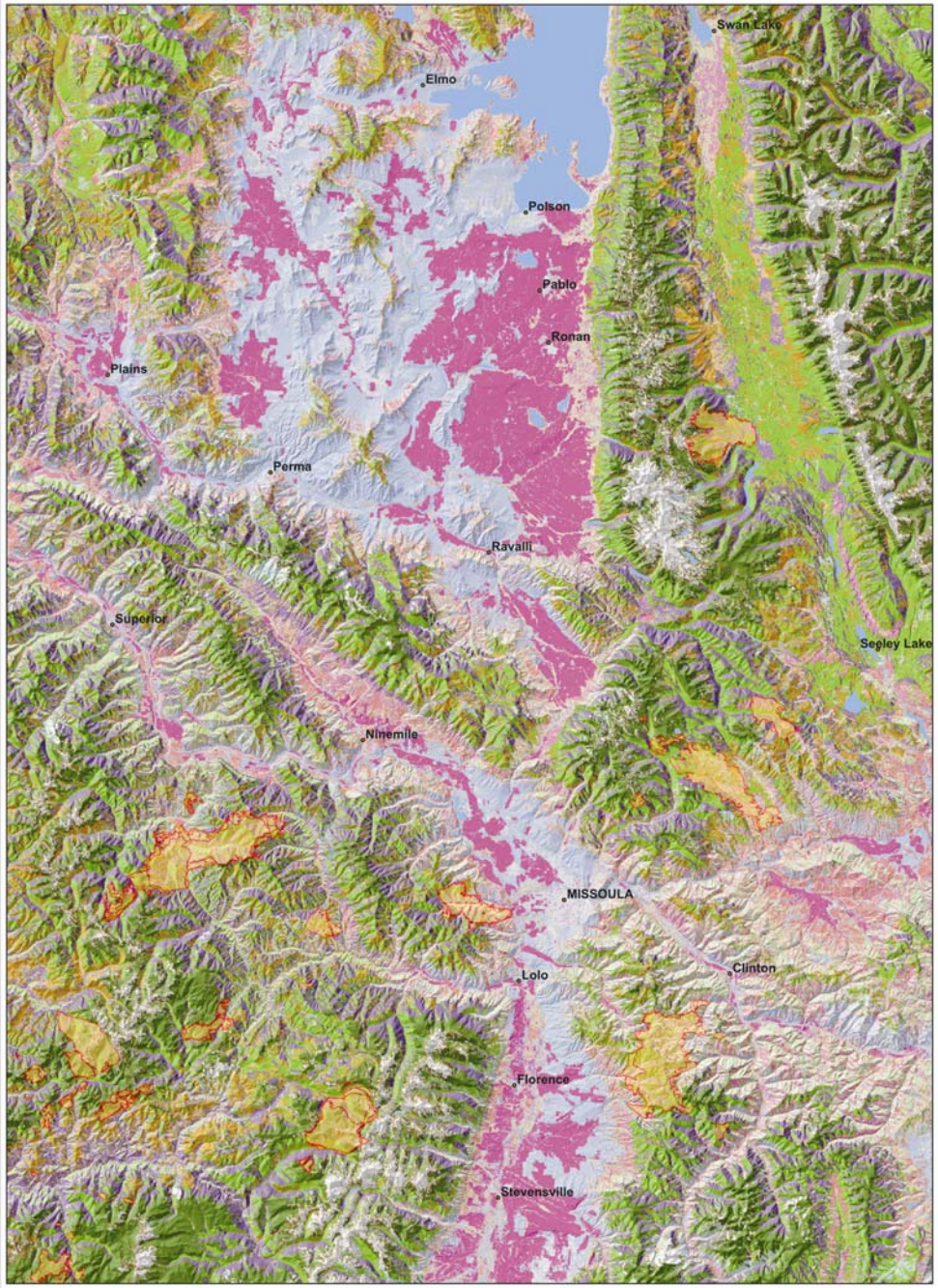
Gil Dustin, BLM Salt Lake City UT

Northern Rockies 2003 Fires: Lessons Learned

NRCG

Northern Rockies Coordination Group


Northwest area command
Missoula area command
Central Idaho area command
Central Montana area command
N
120 miles
Legend
2003 Perimeters (Aug 31)
States
LANDFIRE Zone 19
Northern Rockies Area Command
Area of FARSITE layers mapped by MFiSL
Ownership
BOR
FWS
BIA
BLM
USFS
NPS



Fire Behavior Fuel Models For Missoula Area August 2003

Legend

- Cities
- Highways
- Fire Perimeters (September 7, 2003)

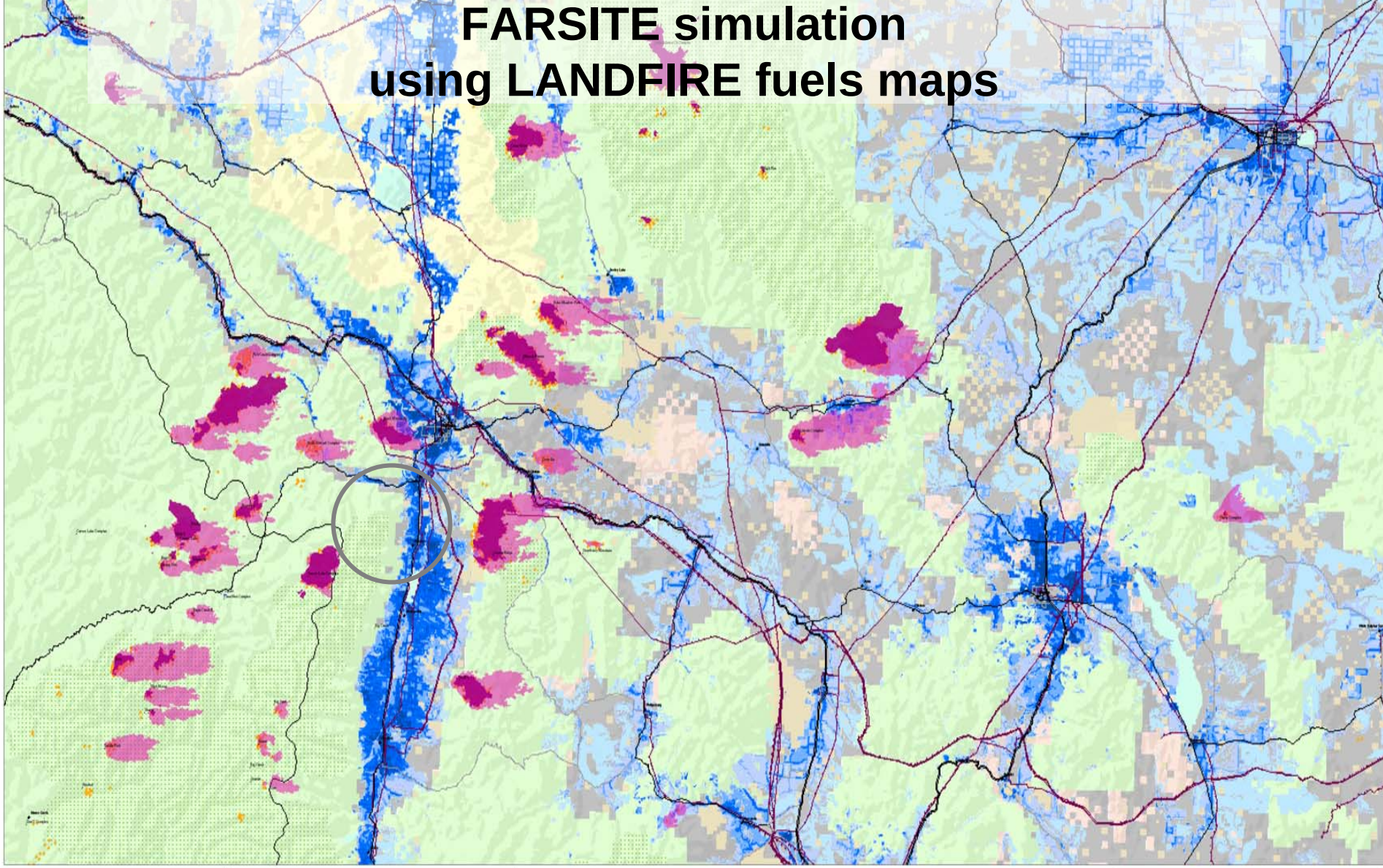
Fire Behavior Fuel Model

- XericMontane_1
- MesicMontane_1
- LowerSubalpine_1
- XericMontane_2
- XericMontane_5
- MesicMontane_5
- LowerSubalpine_5
- UpperSubalpine_5
- XericMontane_8
- MesicMontane_8
- LowerSubalpine_8
- UpperSubalpine_8
- XericMontane_9
- XericMontane_10
- MesicMontane_10
- LowerSubalpine_10
- Water
- Agriculture
- Barren-Rock

FireLab MISSOULA, MONTANA · FIA · USGS science for a changing world

0 4 8 16 Miles

FARSITE simulation using LANDFIRE fuels maps



Legend

FARSITE Data (Aug 18 PM)
- FARSITE Simulation

MODIS Data (Aug 25 AM)
- MODIS Active Fire (Last 12 hours)
- MODIS Previous Fire (Starting Aug 9)

Current Perimeters
- IR Flights (Aug 18 through Aug 25 AM)

Population Density for Region 1
- 0.1-1 People / Sq.Mile
- 2-5 People / Sq. Mile
- 6-25 People / Sq. Mile
- 26-100 People / Sq. Mile
- 101-300 People / Sq. Mile
- > 300 People / Sq. Mile

Ownerships
- BIA
- BLM
- FS
- NPS
- Other Federal Lands
- MT State Ownership
- Non Federal Ownership
- National Wilderness Areas
- powerlines
- Rural Interstate
- Urban Interstate
- Rural Principal Arterial
- Urban Principal Arterial
- roads
- states
- Cities

FARSITE Simulation Information

Simulation: 1 Burn Period

Winds: Speed - 30 miles per hour
Direction -- due west
Time -- 1100 to 2200

Relative Humidity: Low - 16% at 1400
High - 60% at 0600

Temperature: 92 F
In Missoula

MODIS Information

Groupings of Satellite Passes

Map	Times
AM:	2350 and 0400
PM:	1150 and 1400

Each circle represents 250 acres.

If cloud cover is to thick, MODISwill not record hot spots for that pass.

0 3.5 7 14 21 28 Miles

SOURCES

MODIS Information -- Provided by Fire Chemistry at the FIRELAB
FARSITE Projections -- Provided by Fire Behavior at the FIRELAB
Base Map -- Developed by Fire Effects at the FIRELAB
Population Density -- Northern Region Cohesive Strategy Team
Fire Names -- From the 209s
MT Ownership -- From NRIS
Ownership, Roads, Cities, & States -- Provided by ESRI

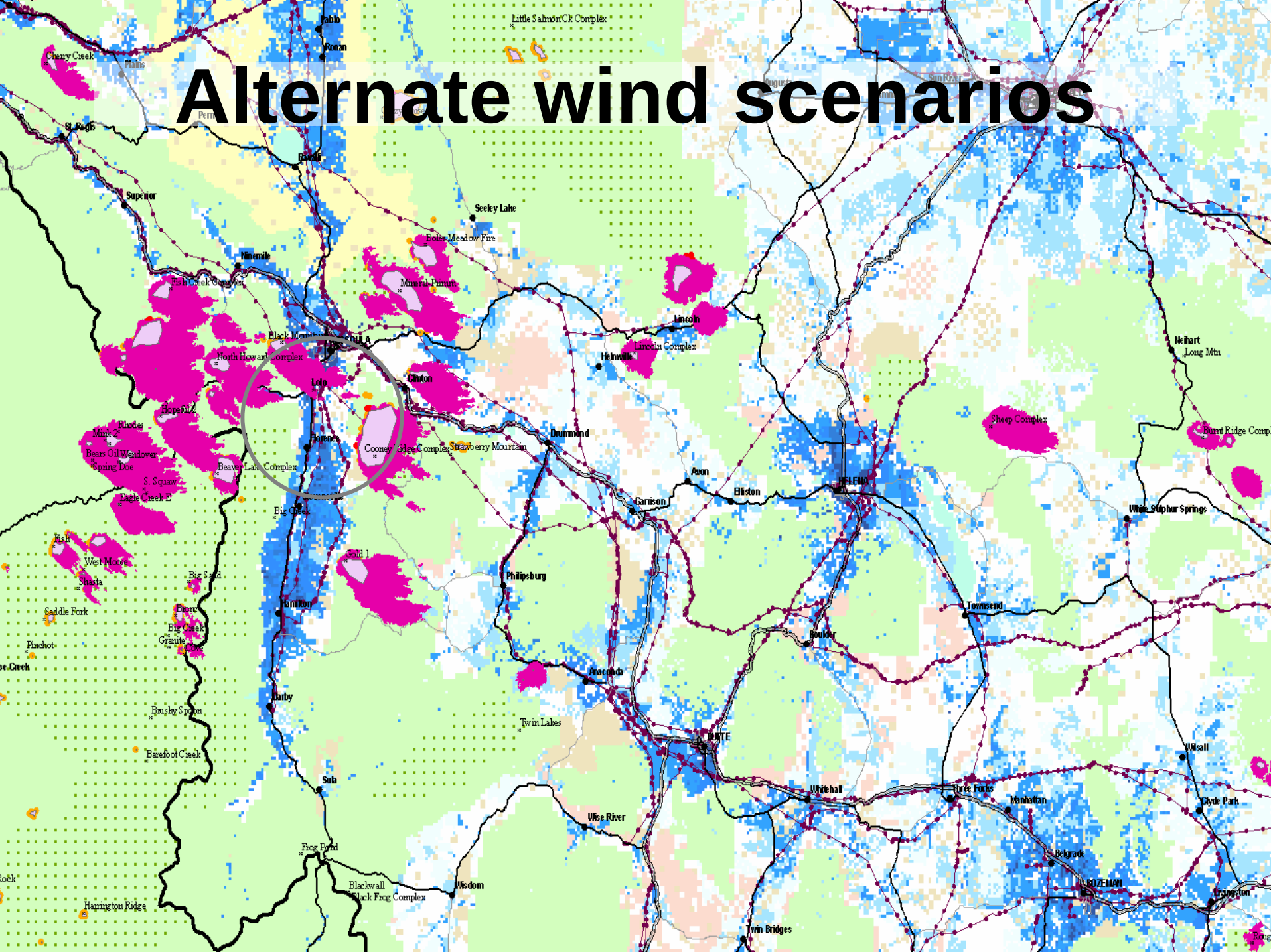
INFORMATION

The information used to create the FARSITE Simulations and the base data required to run FARSITE is based on Research and Development funded by the National Fire Plan. Research used to create the base data for FARSITE was based on the LANDFIRE prototype.

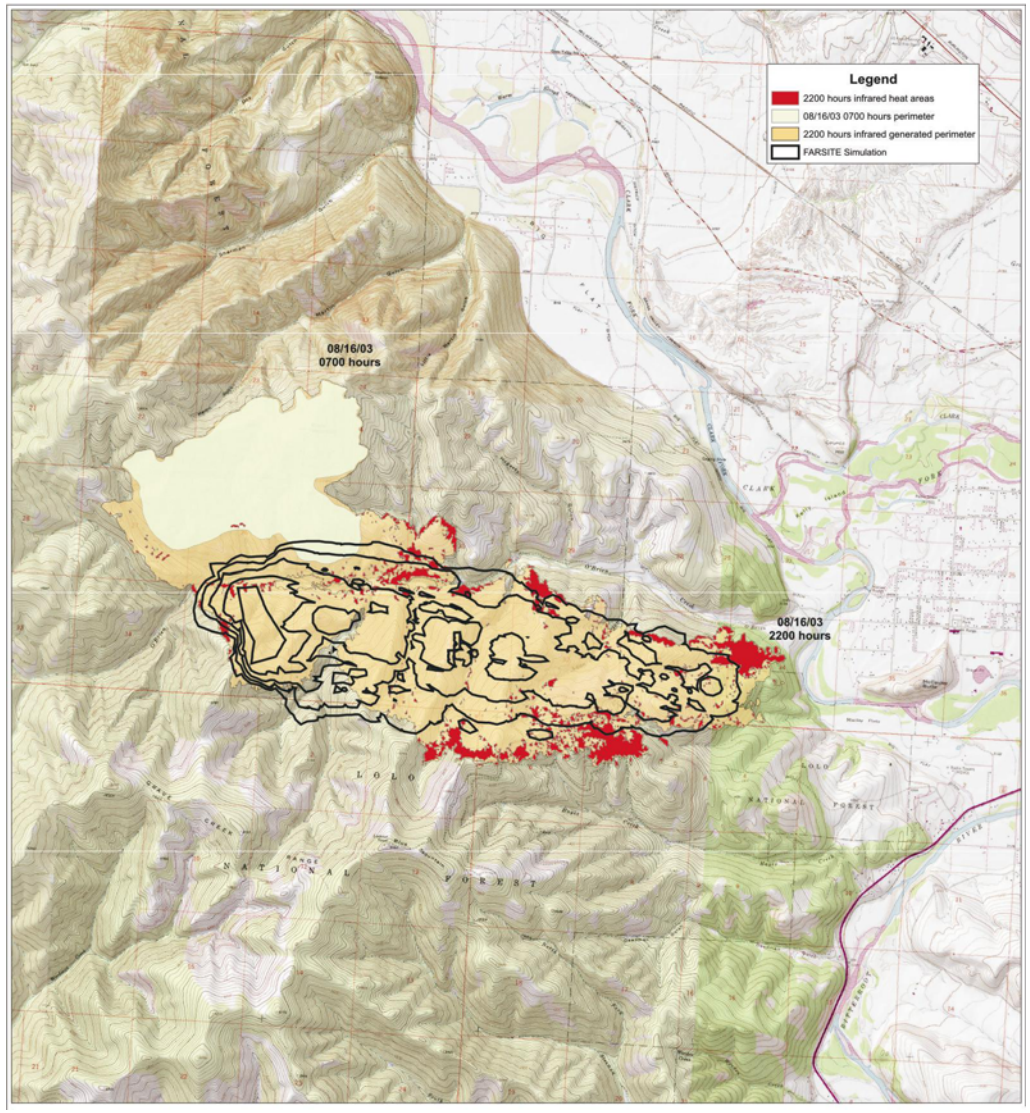
RMRS

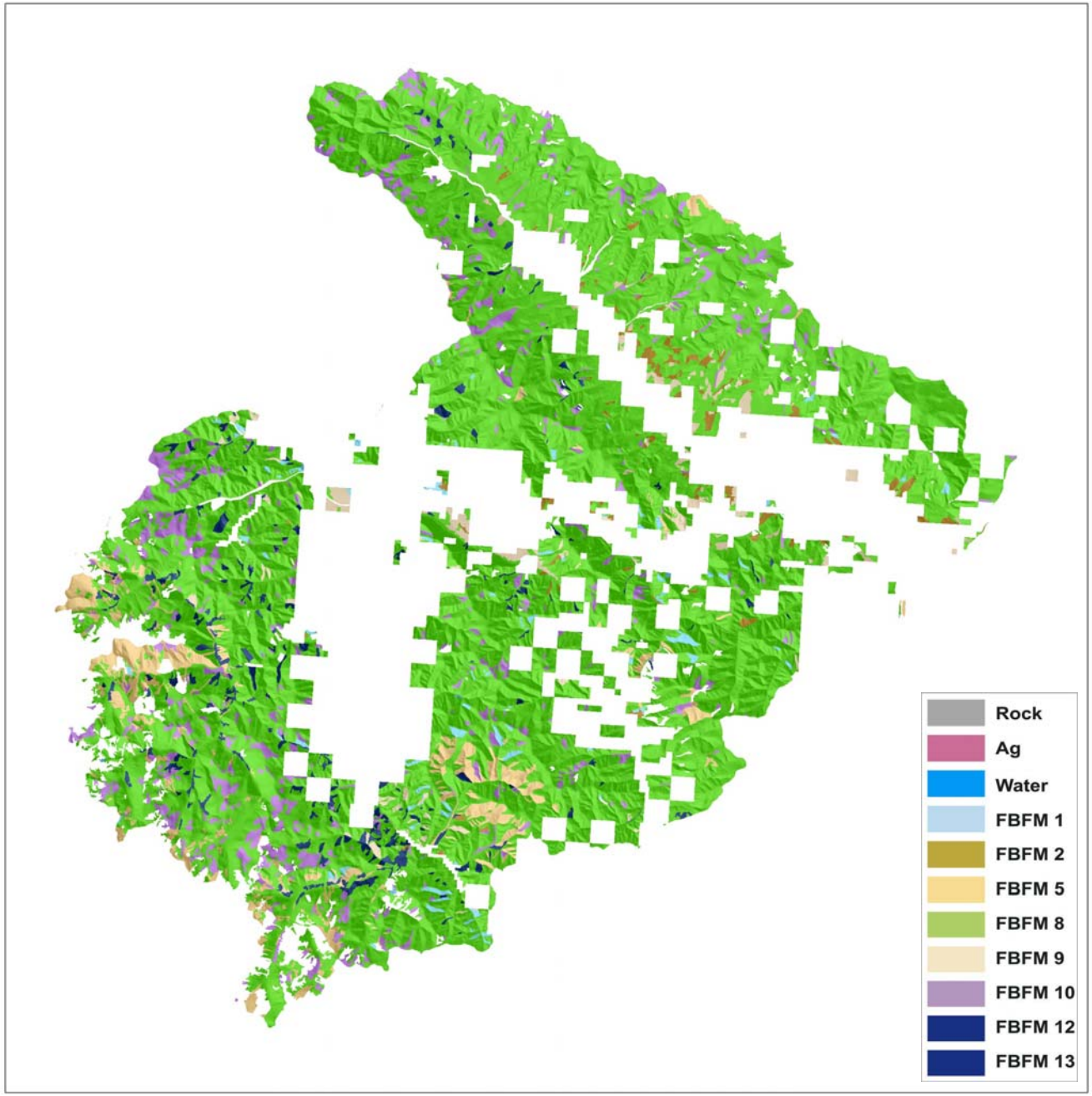
Produced by FireLab MISSOULA, MONTANA

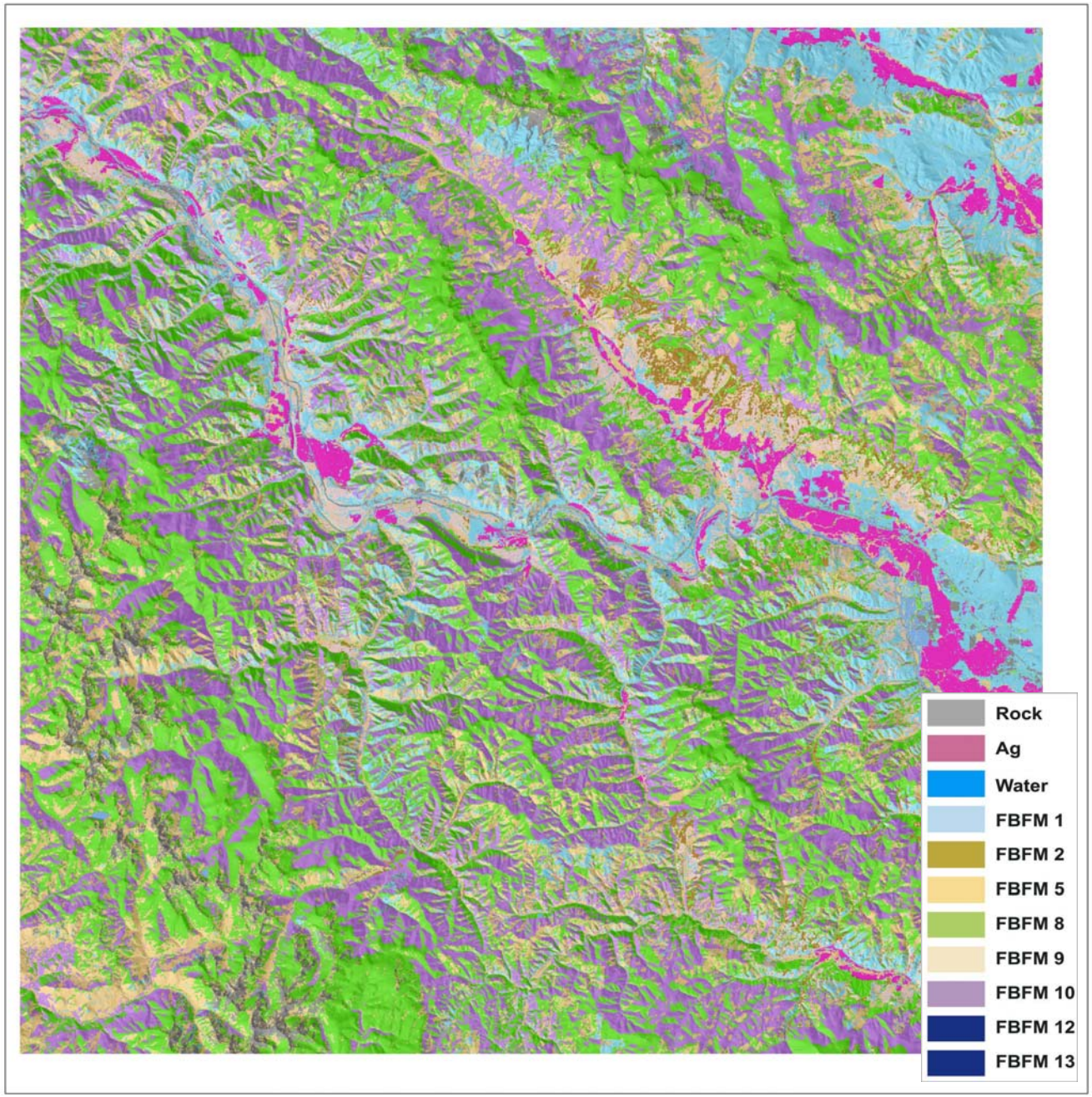
Alternate wind scenarios



Black Mountain/2 Incident




Rock
Ag
Water
FBFM 1
FBFM 2
FBFM 5
FBFM 8
FBFM 9
FBFM 10
FBFM 12
FBFM 13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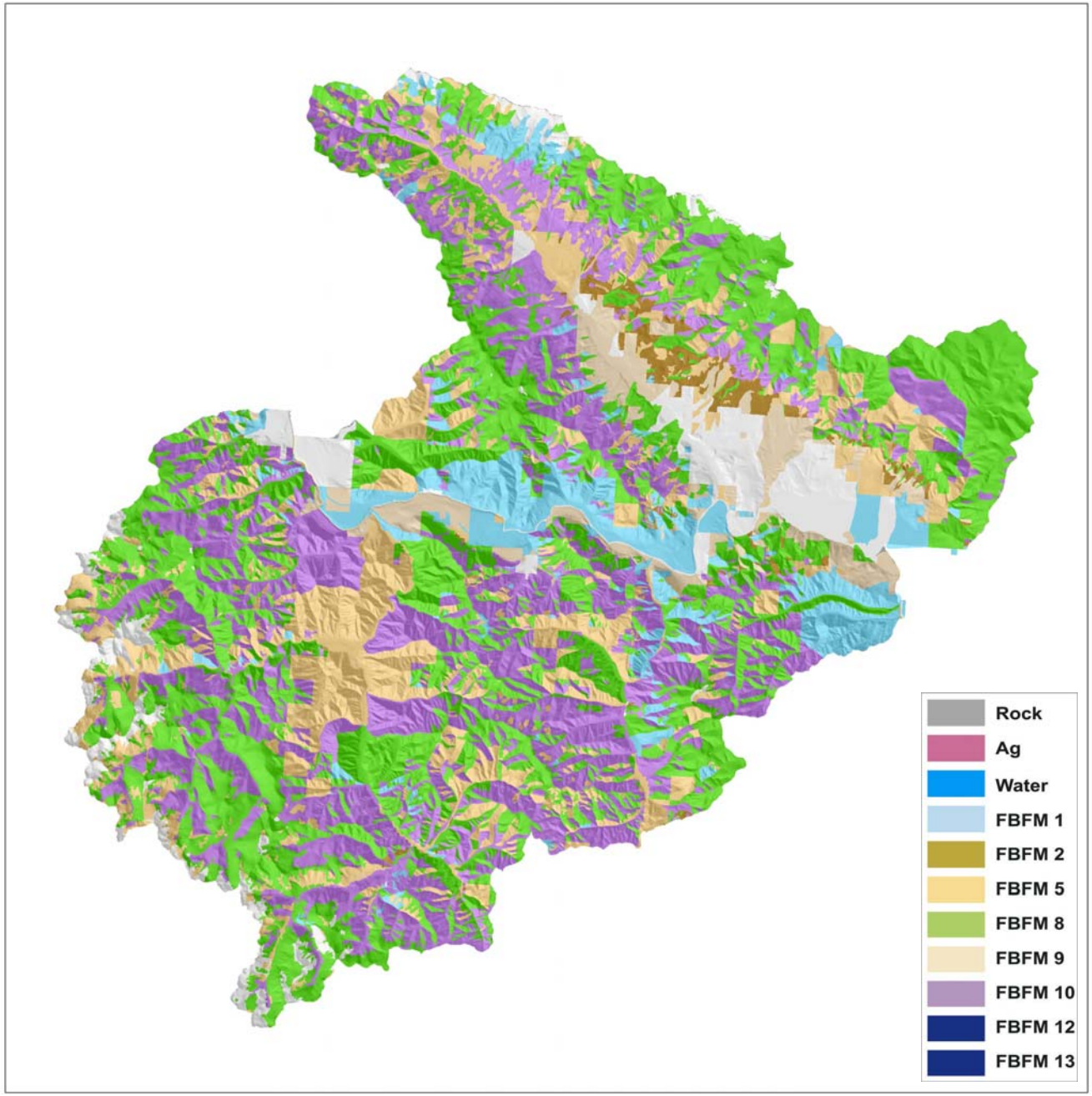
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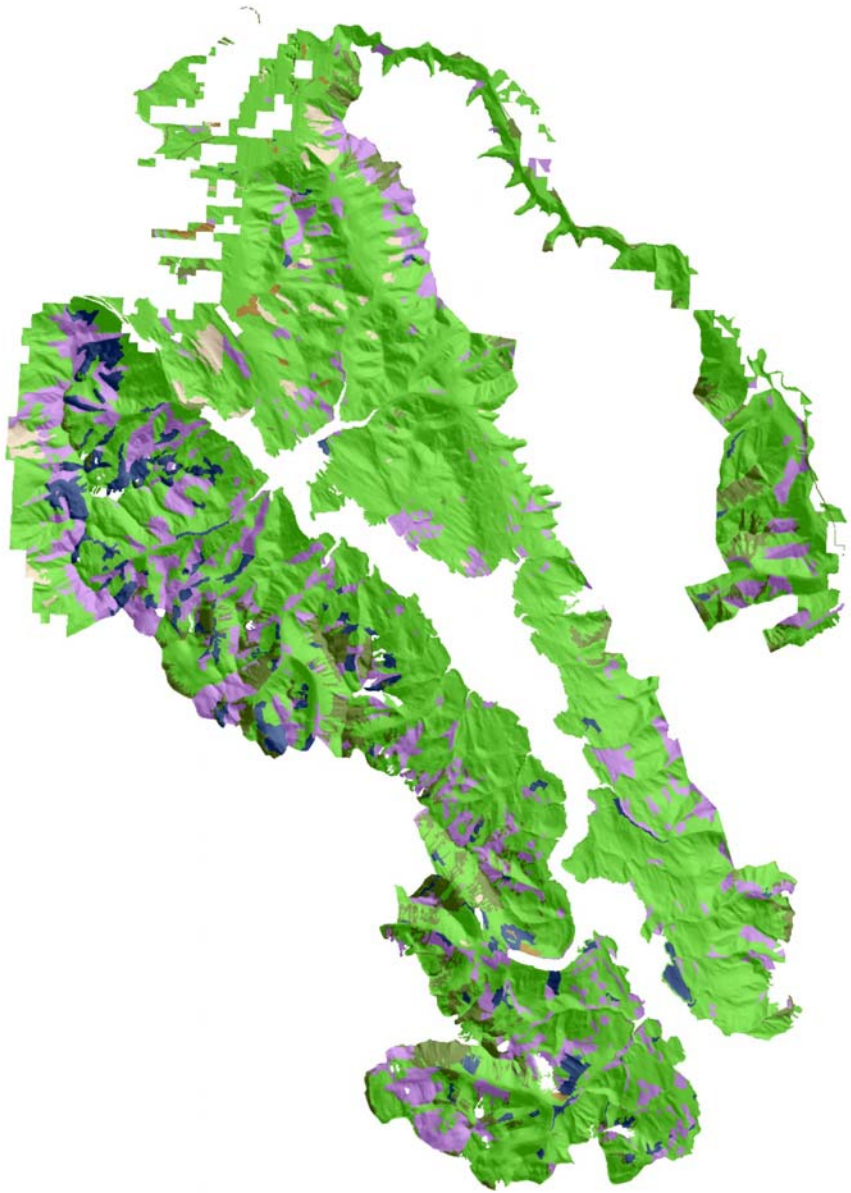
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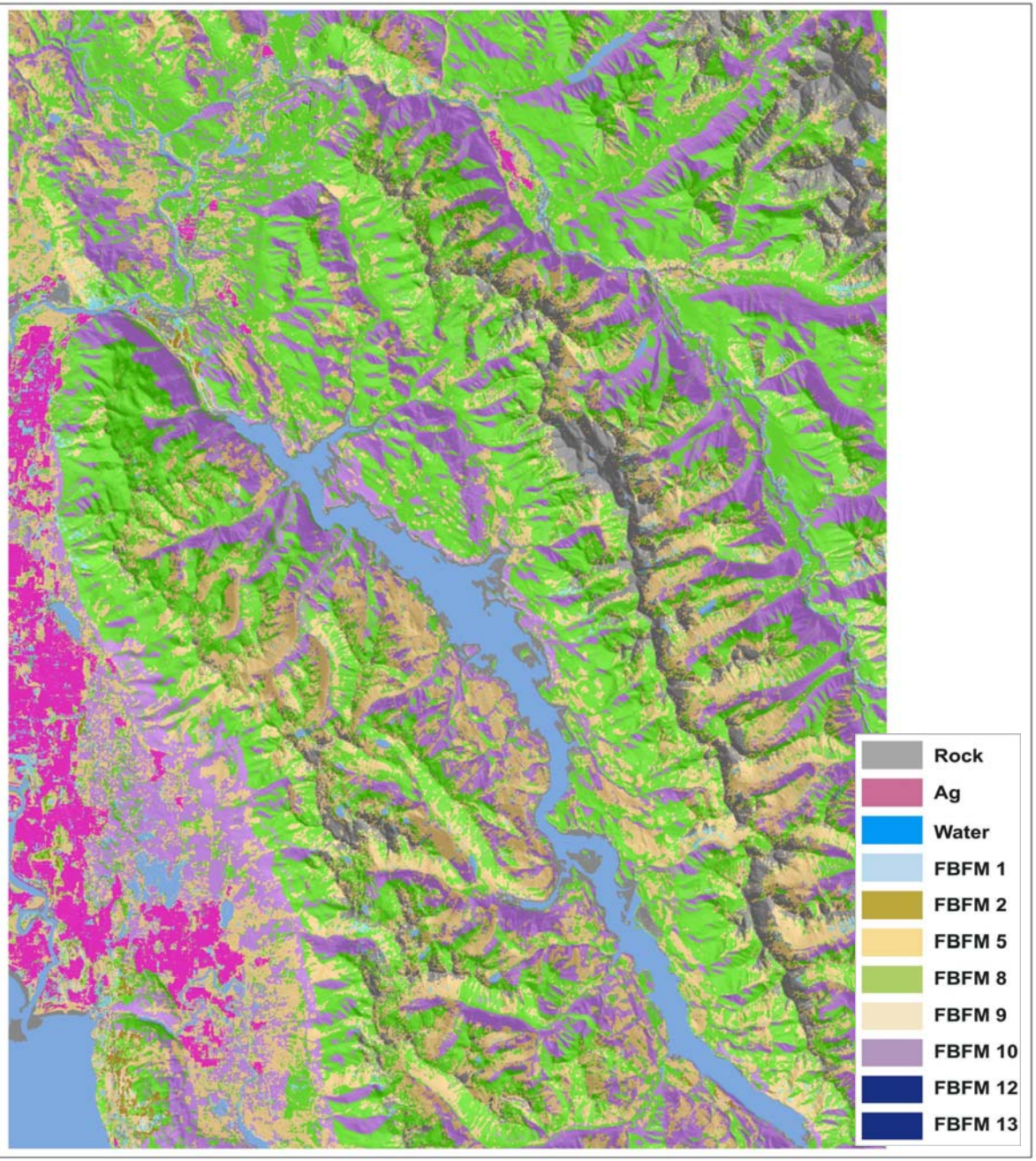
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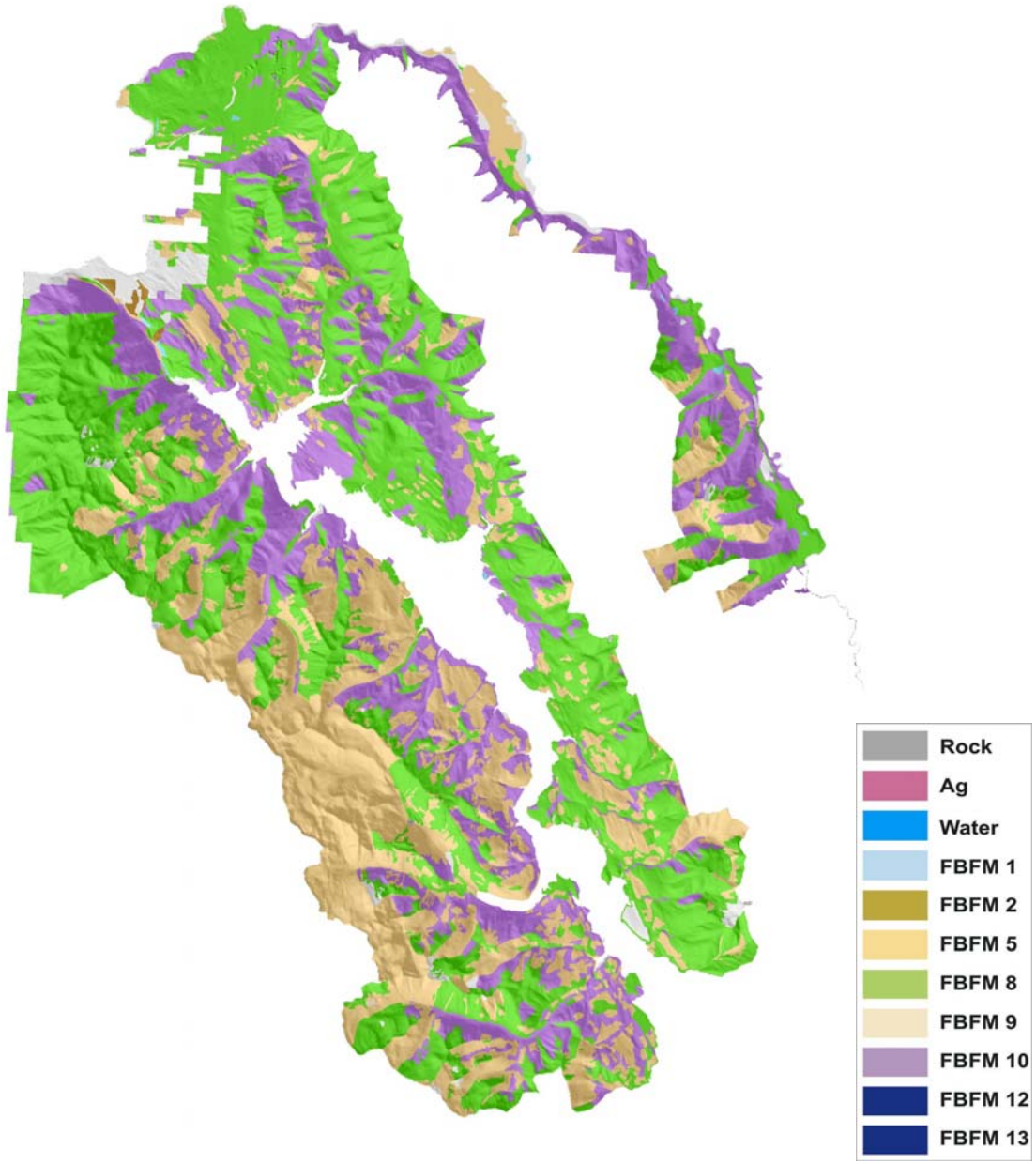
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