Wildfire burned area & burn severity are increasing with climatic warming

Can science and community involvement provide a way forward?

Climate change influences on fire behavior & effects

Climate models predict:

- Later snow on dates, earlier snowmelt
- Warmer winters, reduced snowpack
- Lower late season flows
- Hotter & drier summers
- Higher daytime TEMPs, lower daytime RH
- Higher minimum nighttime TEMPs
- More stalled high-pressure systems
- Higher lightning incidence
- Less PRECIP during the fire season
- More frequent strong convective storms
- Longer fire seasons
- More frequent, longer, worsening droughts

Effects on fire & fuels:

- Reduced PAW will kill some trees outright
- Others weakened & be vulnerable to I & Ds
- Live and dead fuels will dry out, be available to burn earlier/longer
- Burned area will increase annually to a point
- Patches of high severity fire will be larger
- Reburns will increase in frequency
- Some large, severely burned areas will fail to reforest
- Grass, shrub, woodland area will increase
- Landscape patch grain will coarsen

Looking to the past to understand the changes

Strong historical evidence of a complex lifeform patchworks; this was important context for forest seral stage patchworks

- Fire regimes varied by forest type; variability differed from ecoregion to ecoregion
- Climate always drives variability in fire regimes; but now so even more.
- Lifeform & seral stage patchworks resulted from intentional First Nations burning & lightning ignitions
- Lifeform & seral stage patterns regulated forest vulnerability to I & Ds by influencing patterns of forest cover types, patch sizes, structural conditions
- To better understand changes leading to current conditions, it is useful to determine ranges of historical patterns of lifeform/forest seral stage/fuel patchworks

Look to the future for the path ahead

Regardless of past changes, disturbance and climatic regimes, forest environments will change

- This will influence lifeform & forest seral stage patchworks
- Influencing habitats, vulnerability to I & Ds, stream temp and flows, fish abundance, and more
- To better understand these changes, it will be useful to determine future ranges of variability in patterns of lifeform, seral stage/fuel patchworks
- Several CC scenarios should be considered

Landscape resilience project for the Quesnel TSA

- The pilot project is a learning laboratory
- Consists of an integrated program of R&D/mgt/habitat planning
- Designed to better understand the nature of past, present & future climates
- Associated landscape patterns & disturbance processes
- Will enable mgt in the context of likely climate & wildfire regimes
- Not to eradicate LRG disturbances/change
- But to (re)build forests/ranges for a future…
- …adapted to new climate/fire regimes
- …where mgt cooperates w/ what lies ahead.

View SW from Mission Peak, Okanogan-Wenatchee National Forest, 10 miles SW of Wenatchee, WA 08/19/1934 Reino R. Sarlin USFS from National Archives and Records Admin. Seattle, WA 09/10/2010 John F Marshall for USFS

IMMEDIATE PRIORITIES:

WE NEED TO BUY TIME FOR LANDSCAPE ANALYSIS AND RESTORATION PLANNING AND FIGURE OUT A RAPID MECHANISM TO PREPARE THE LANDSCAPE FOR MANAGERS TO CONSTRAIN, HOOK, BOX, STEER AND HOLD WILDFIRE

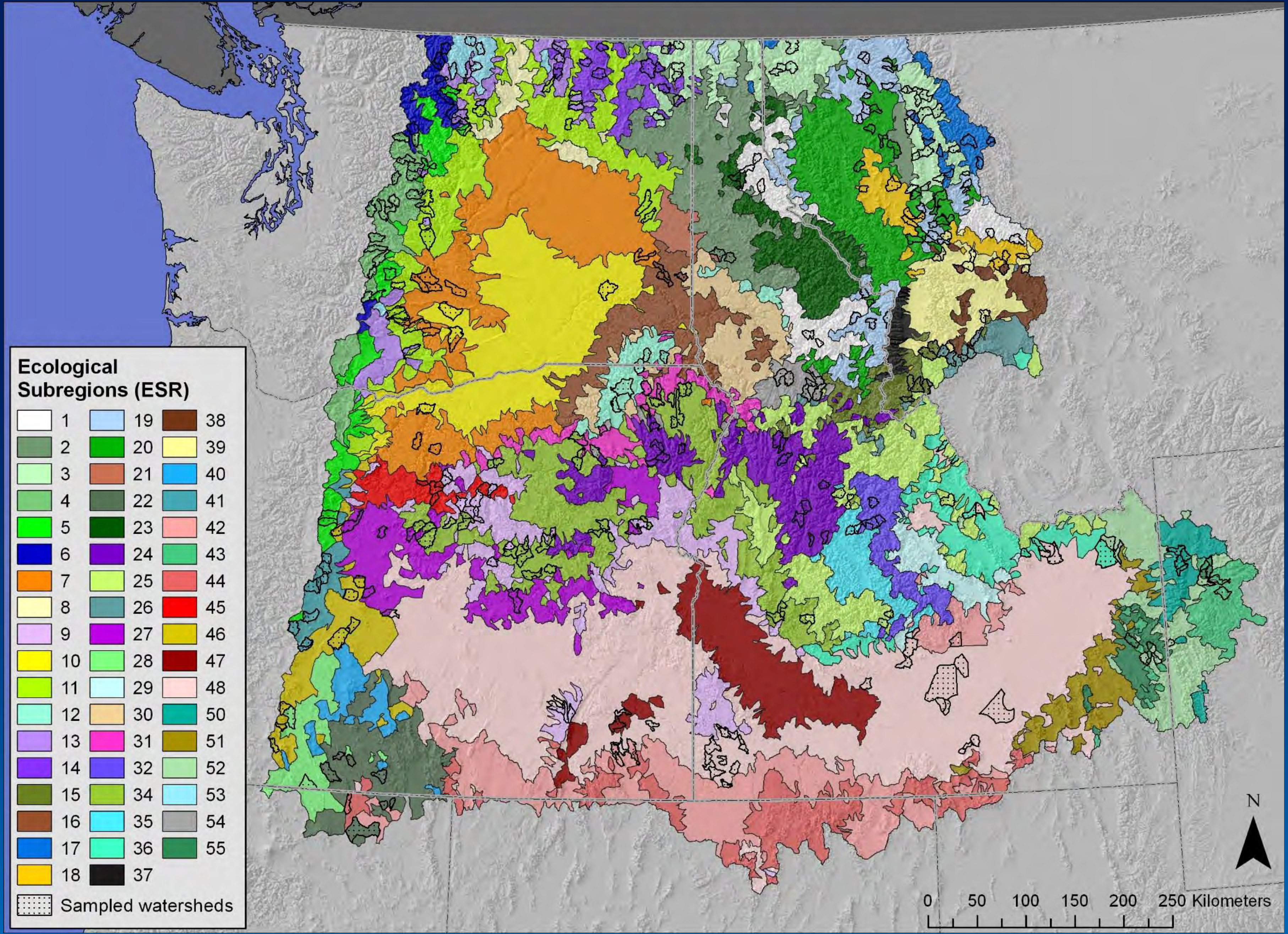
PRIORITIES

- Protect communities and critical infrastructure
- Opportunistically manage some wildfires to increase landscape resiliency
- Reduce in mean fire size
- Mitigate fire severity of future wildfires

REDUCING FIRE SIZE AND SEVERITY

- How can we constrain fire size?
- How do we identify existing anchors on the landscape?
- How to identify and create new anchors on the landscape?
- Where are our least "fuelly" parts of the landscape?
- How best to manage those least "fuelly" parts of the landscape over the short term?

Hessburg et al. 2000. For. Ecol. Mgt. 136: 53-83.



Hessburg et al. 2000. Applied Vegetation Science 3: 163-180

Empirically derived HRV, CRV, FRV conditions

- ✓ Is it spatial patterns, abundances of seral stage/lifeform/fire severity patches we are after?
- ✓ …the associated variation in carbon pools, habitats, forest products?
- ✓ Is it patterns, abundances, PSDs of habitats, I&D & wildfire vulnerability conditions…
- ✓ Is it the associated social acceptability/feasibility of FRV scenarios?

Participants will discuss what we mean by HRV, CRV, FRV conditions, how to determine them, w/ a discussion of available data and resources.

DSTs & SDM tools to evaluate trade-offs among decision criteria for mgt alternatives

- ✓ Use cultural, ecological, socio-economic, habitat criteria
- ✓ Consider mgt responsiveness to predicted climate & wildfire regime changes
- ✓ Dynamism of landscapes, mgt scenarios, cultural, market, manufacturing responses
- ✓ Efficacy/feasibility of mgt/mitigations, life cycle costs, benefits, uncertainties

Participants will develop an initial shell for a landscape management and structured decision making process. And take a 1st cut at defining some important outputs/outcomes/consequences of management decisions.

Example outputs/outcomes (intentionally incomplete):

- ✓ First Nations values
  - ✓ Vegetation types supporting first foods, habitat for ungulates
  - ✓ Habitat for fur bearing species, fisheries,
- ✓ Wildlife habitats
  - ✓ Conditions supporting listed species and those of concern
- ✓ Forest Products
  - ✓ Volume of softwood sawtimber, hardwood/softwood biomass
  - ✓ Volume of hardwood/softwood pulp
- ✓ Carbon sequestration and loss
  - ✓ Volume of emissions, volume of carbon stored by pool
- ✓ Distributed hydrology and sediment yield
- ✓ Social values
  - ✓ Jobs, community sustainability--10 generations
- ✓ Smoke emissions
  - ✓ Total black carbon, PM2.5, PM10.0 particulates

Modules

- Empirically-derived HRV, CRV, FRV
- Simulated HRV, CRV, FRV, did we miss/botch anything?
  - ✓ Using deterministic/non-deterministic simulation tools
  - ✓ Developing mgt scenarios for CRV & FRV conditions
  - ✓ Carbon & habitat dynamics for each mgt scenario
  - ✓ Distributed hydrology/sediment modeling/fish habitat modeling?
- Use DSTs & SDM tools to evaluate trade-offs among decision criteria for mgt alternatives
  - ✓ Use cultural, ecological, socio-economic, habitat criteria
  - ✓ Consider mgt responsiveness to predicted climate & wildfire regime changes
  - ✓ Dynamism of landscapes, mgt scenarios, cultural/market/manufacturing responses
  - ✓ Efficacy/feasibility of mgt/mitigations, life cycle cost/benefits/uncertainties
- Develop a research development & application (RD&A) agenda
  - ✓ Wild & Rx fire, carbon dynamics, economics of proactive/reactive fire management
  - ✓ Social acceptance/impedimentia, community/market resilience
  - ✓ Retooling in manufacturing, burned fiber/hardwood access & utilization.
  - ✓ Other?

The Reburn Project:

Influence of past burn mosaics on future fire behavior and implications for management

Susan Prichard, University of Washington

Paul Hessburg, USFS Pacific Northwest Research Station

Nicholas Povak, USFS Pacific Northwest Research Station

Brion Salter, USFS Pacific Northwest Research Station

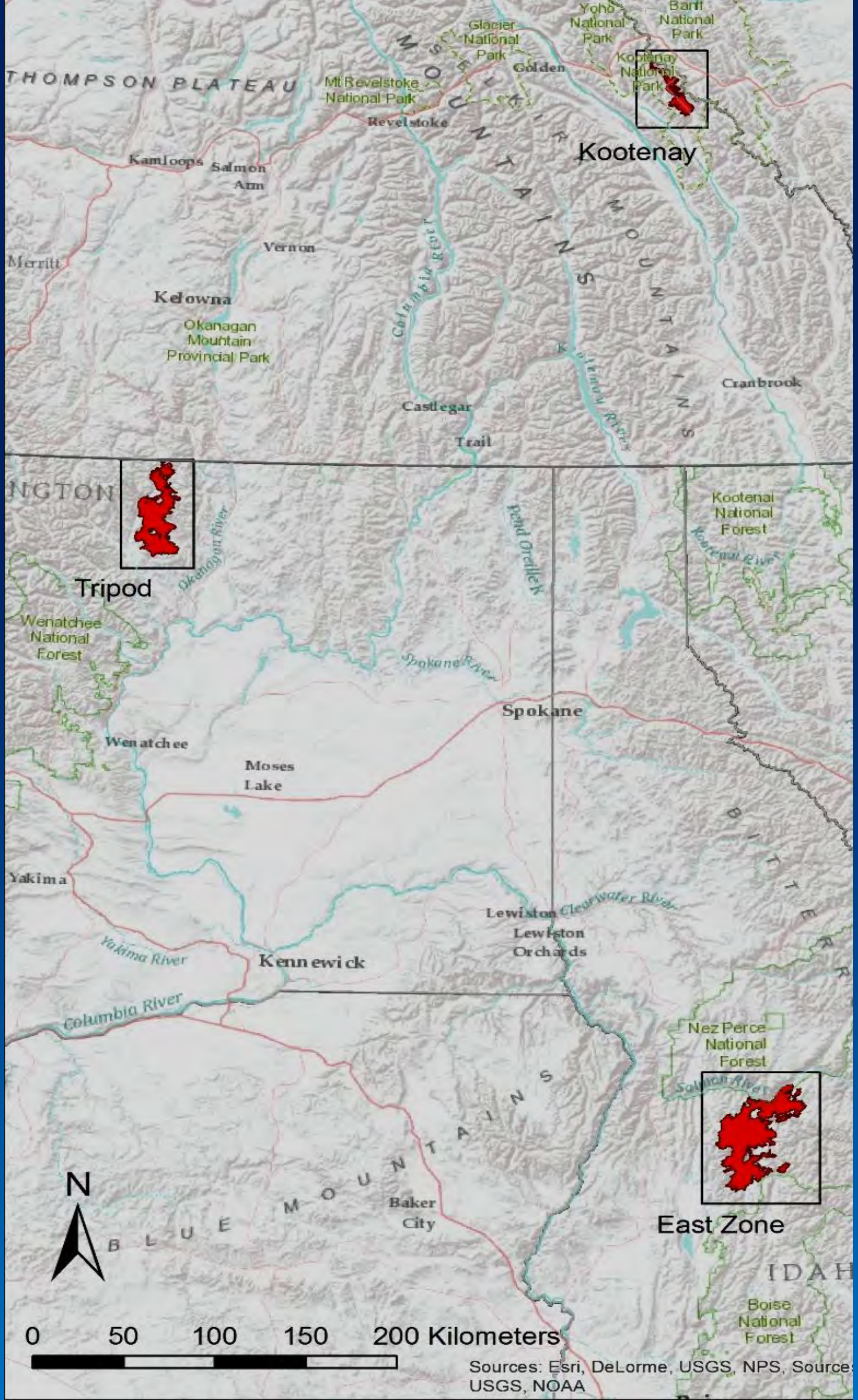
Robert Gray, RW Gray Consulting

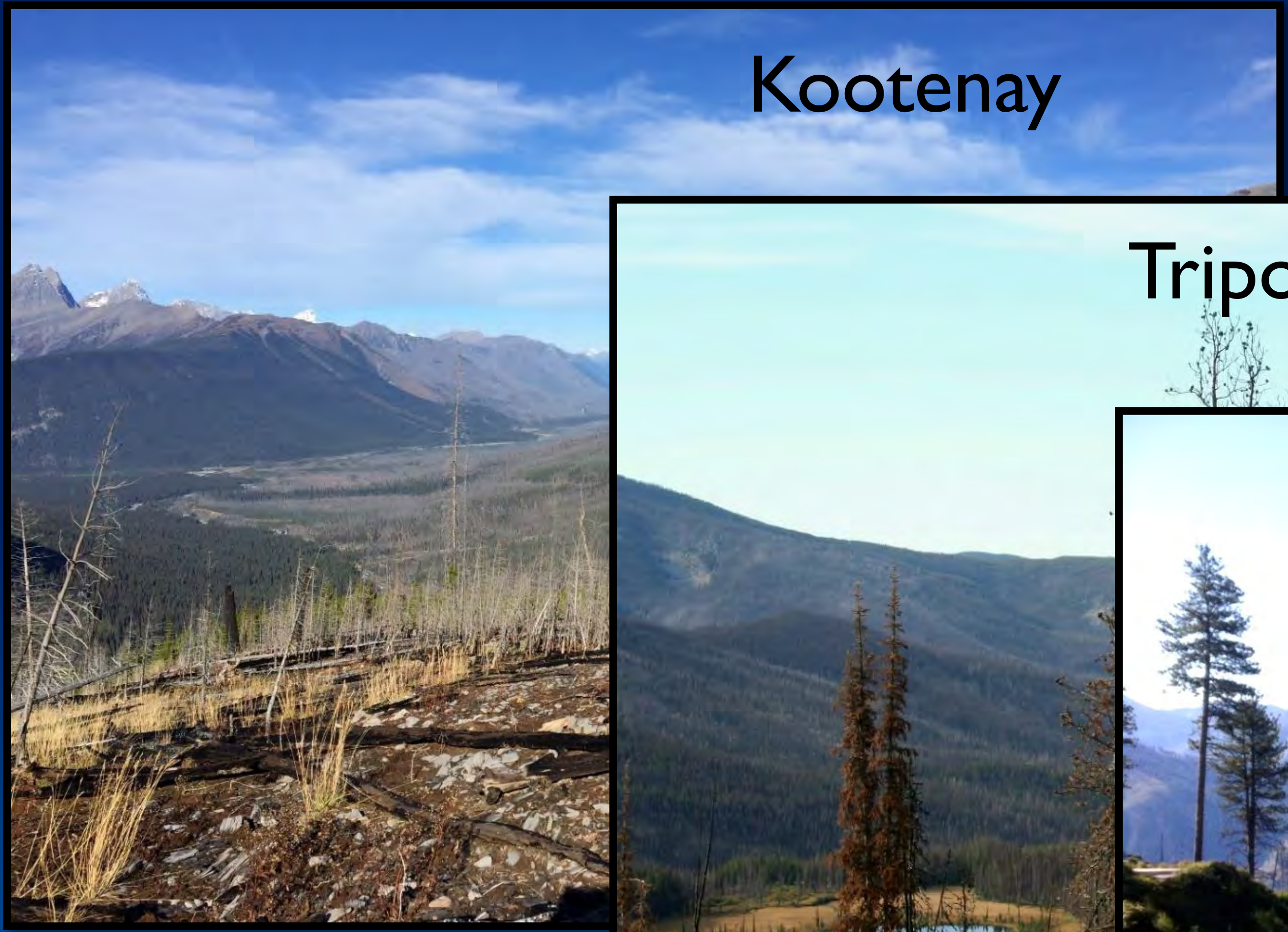
Study Areas and Objectives

To evaluate the effects of past wildfires on the:

1) Characteristics (e.g. fire spread and severity)

2) Management (e.g. firefighting strategies and costs) of subsequent wildfires.

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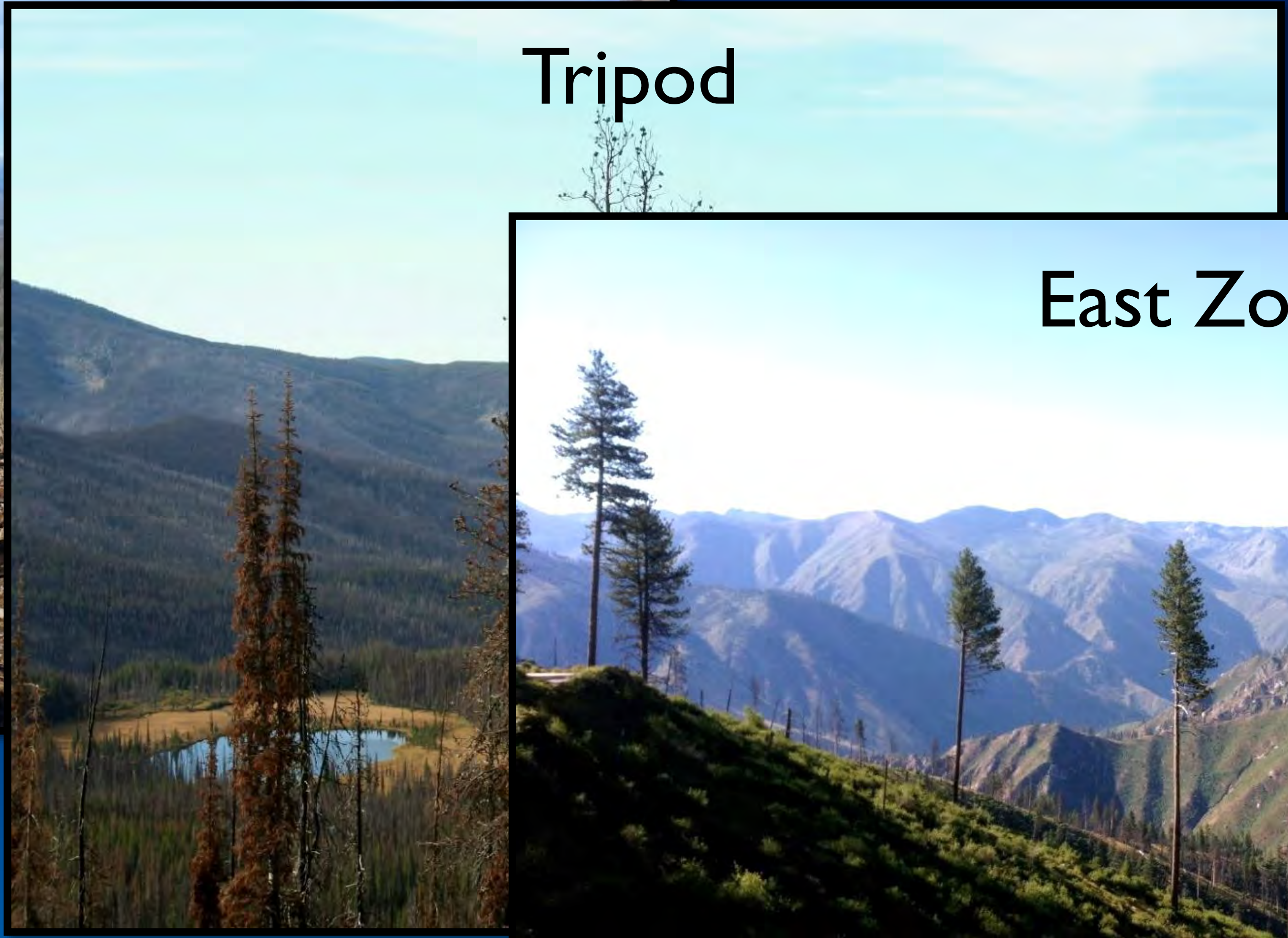
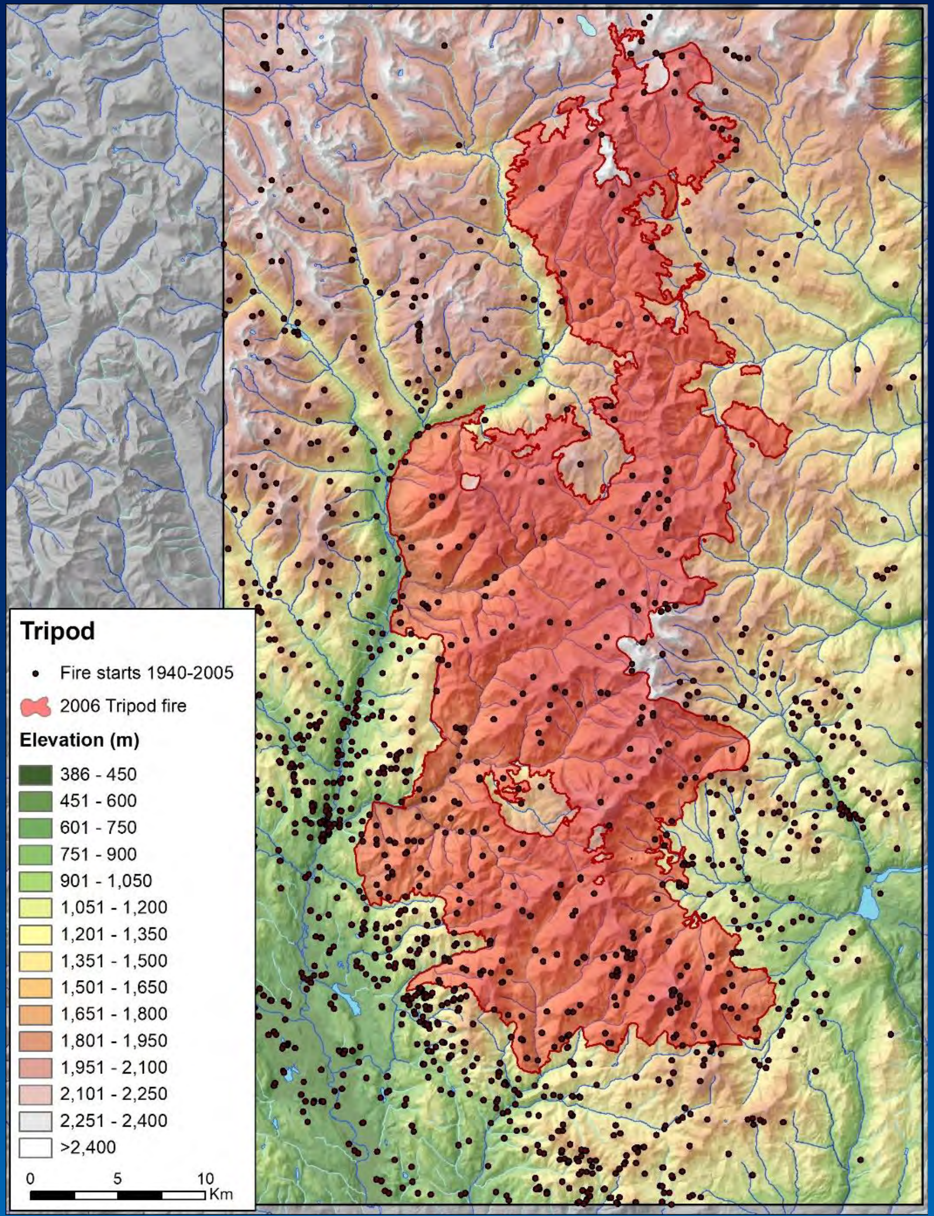

Tripod

East Zone

Tripod Historical Fire Starts

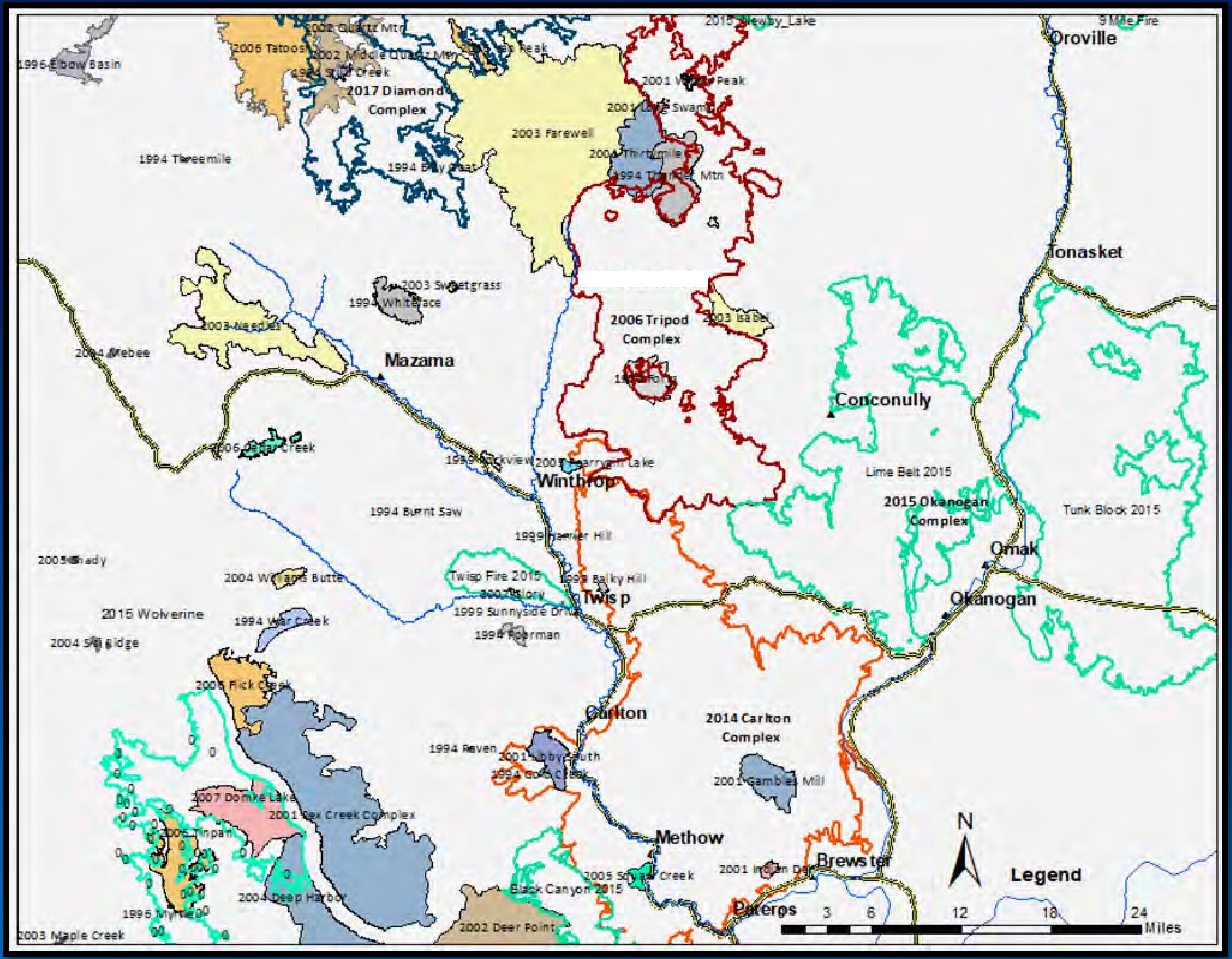


Suppressed fire starts (1940 – 2006, n > 300)

Research Questions

1) How do the location, size and age of past wildfires influence subsequent wildfire behavior and effects?

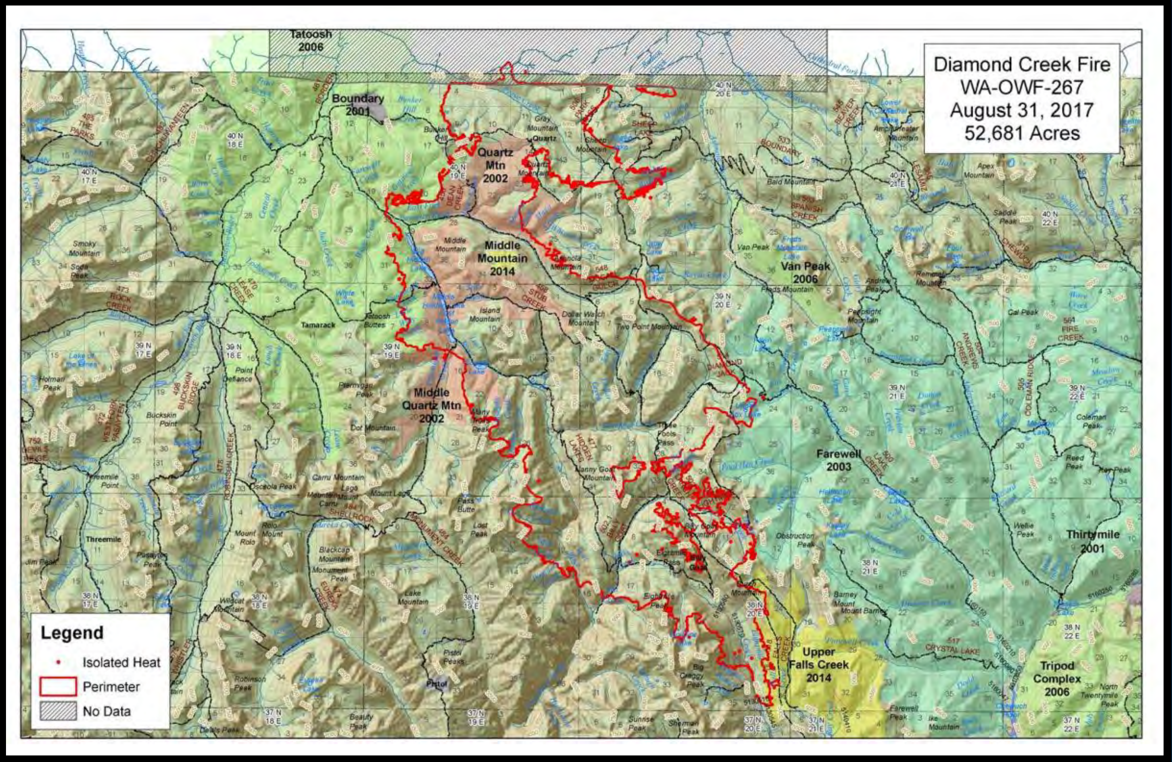
2) Were past wildfires effective as barriers to subsequent fire spread or to mitigate burn severity?



Research Questions

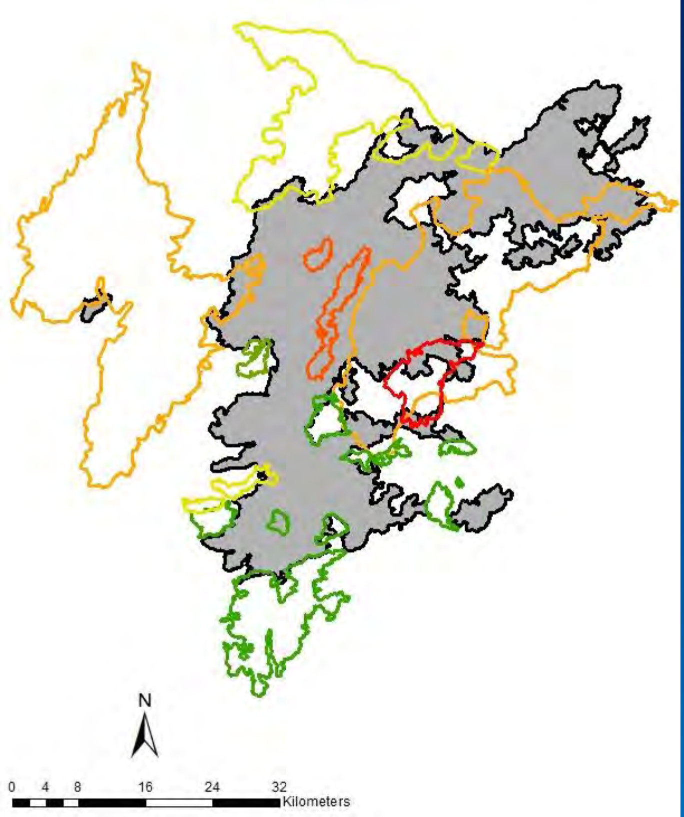
3) How do past wildfires influence or inform management strategies for subsequent wildfires?

For example, how can past wildfires be used in safe and effective strategic and tactical responses to large, high severity fire events?

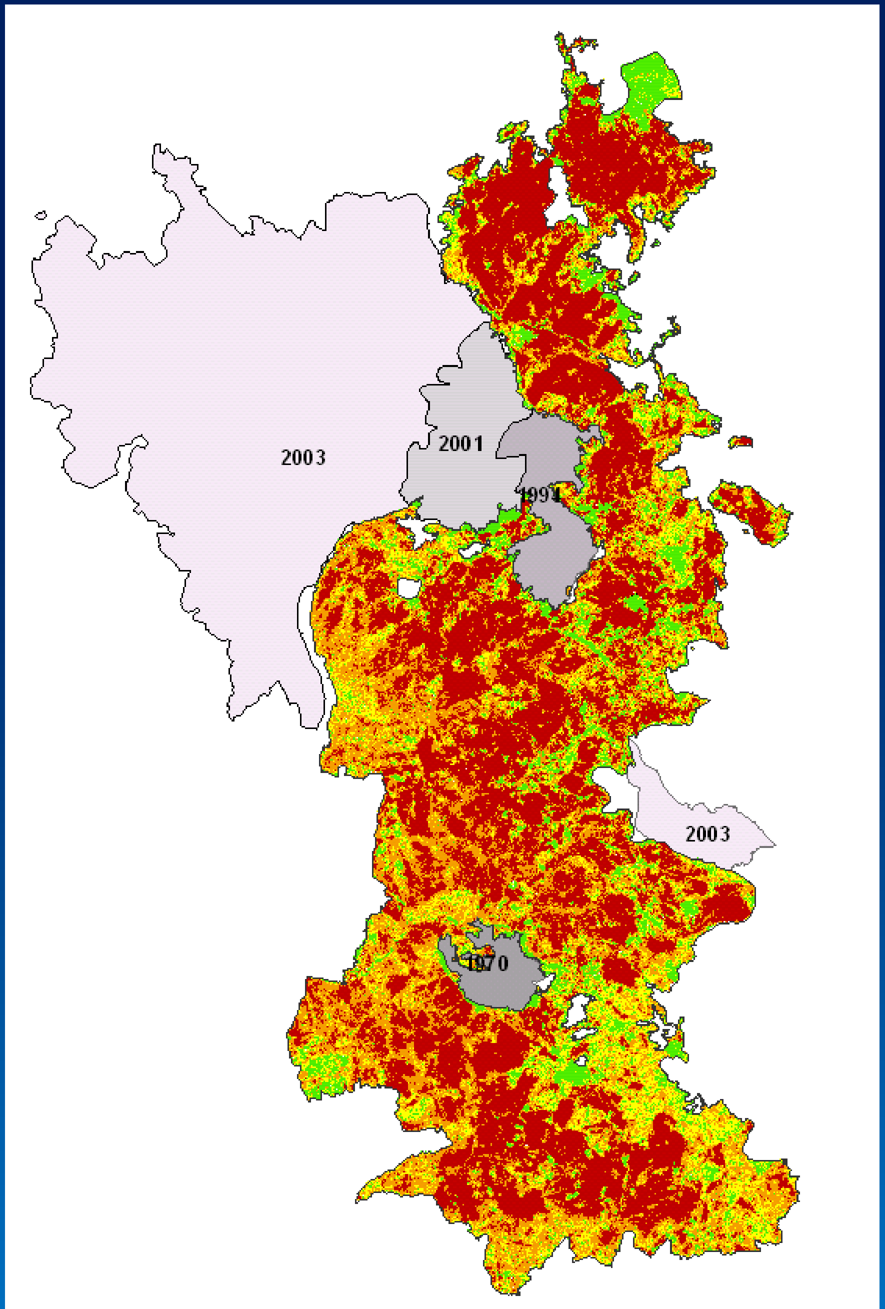


Task 1: Burn Severity Analysis

- Across all study areas, past burns mitigated the burn severity of the subsequent wildfire
- Even under extreme fire weather conditions, vegetation, topography, and past burn severity all influenced reburn severity



2006 Tripod Complex Fires



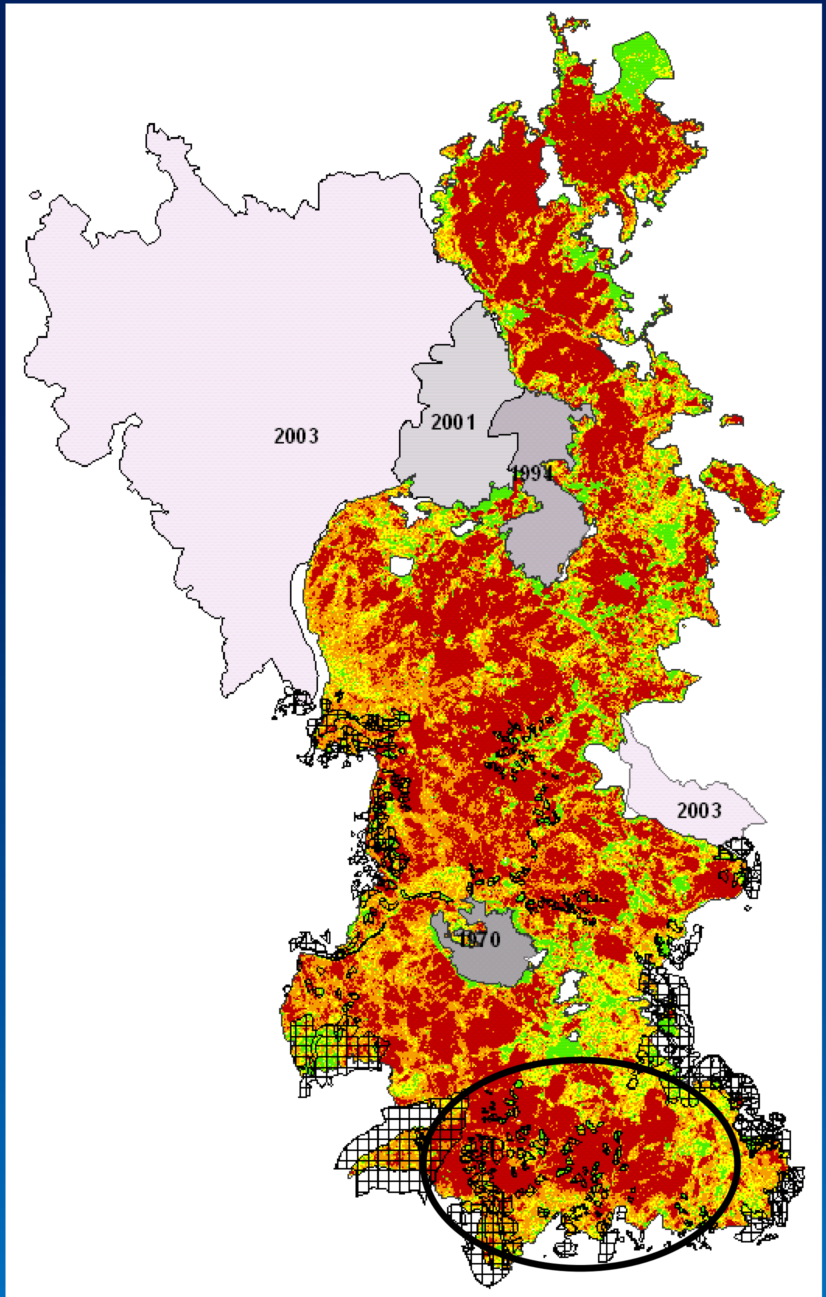
Severity Class

- High
- Moderate
- Low
- Unburned

Historic Fires

- Farewell & Isabel (2003)
- Thirtymile (2001)
- Thunder Mtn (1994)
- Forks (1970)

Fuel Treatments



Severity Class

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- Moderate
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Historic Fires

- Farewell & Isabel (2003)
- Thirtymile (2001)
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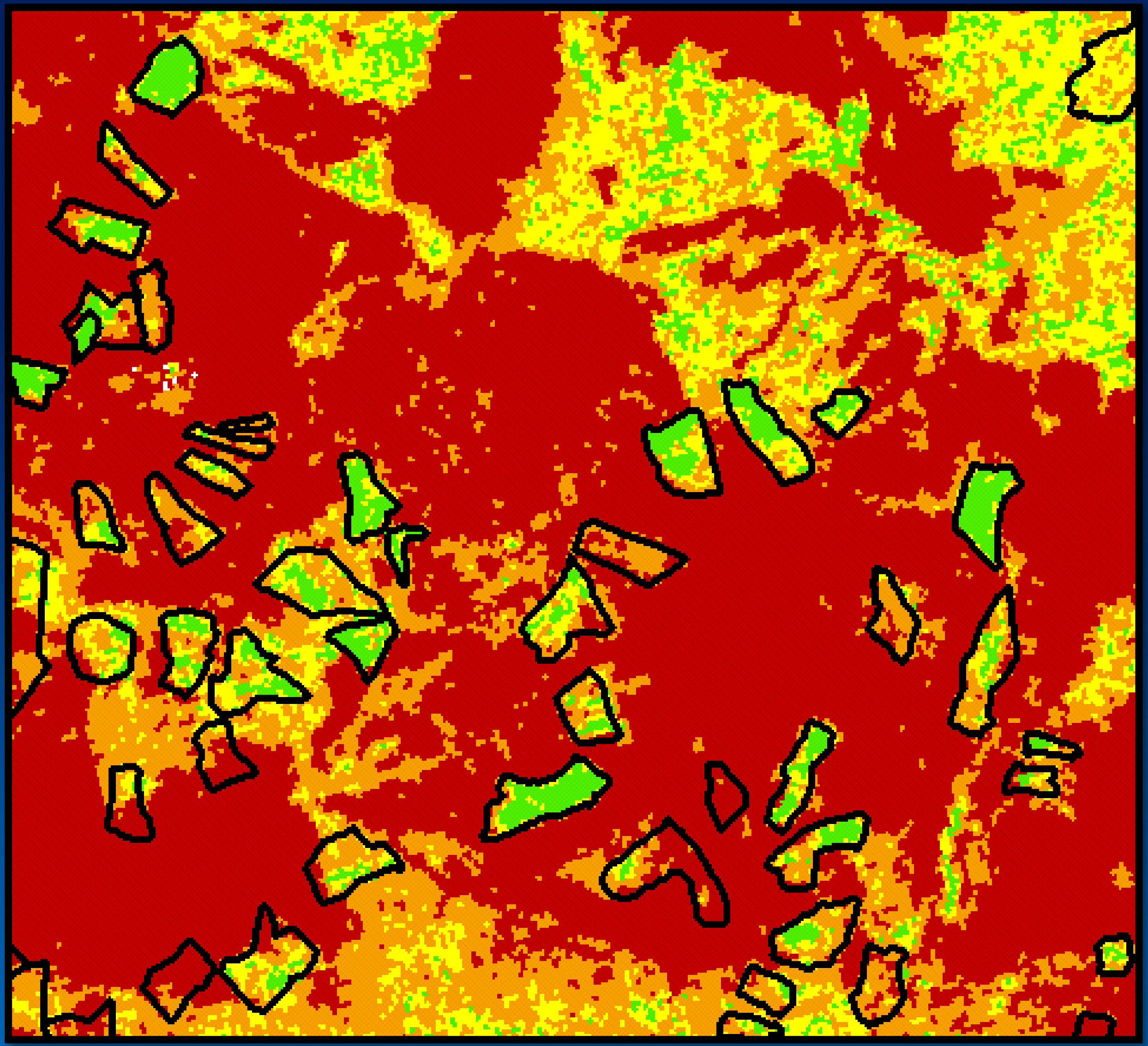
- Forks (1970)

Fuel Treatment

Past Prescribed Burns

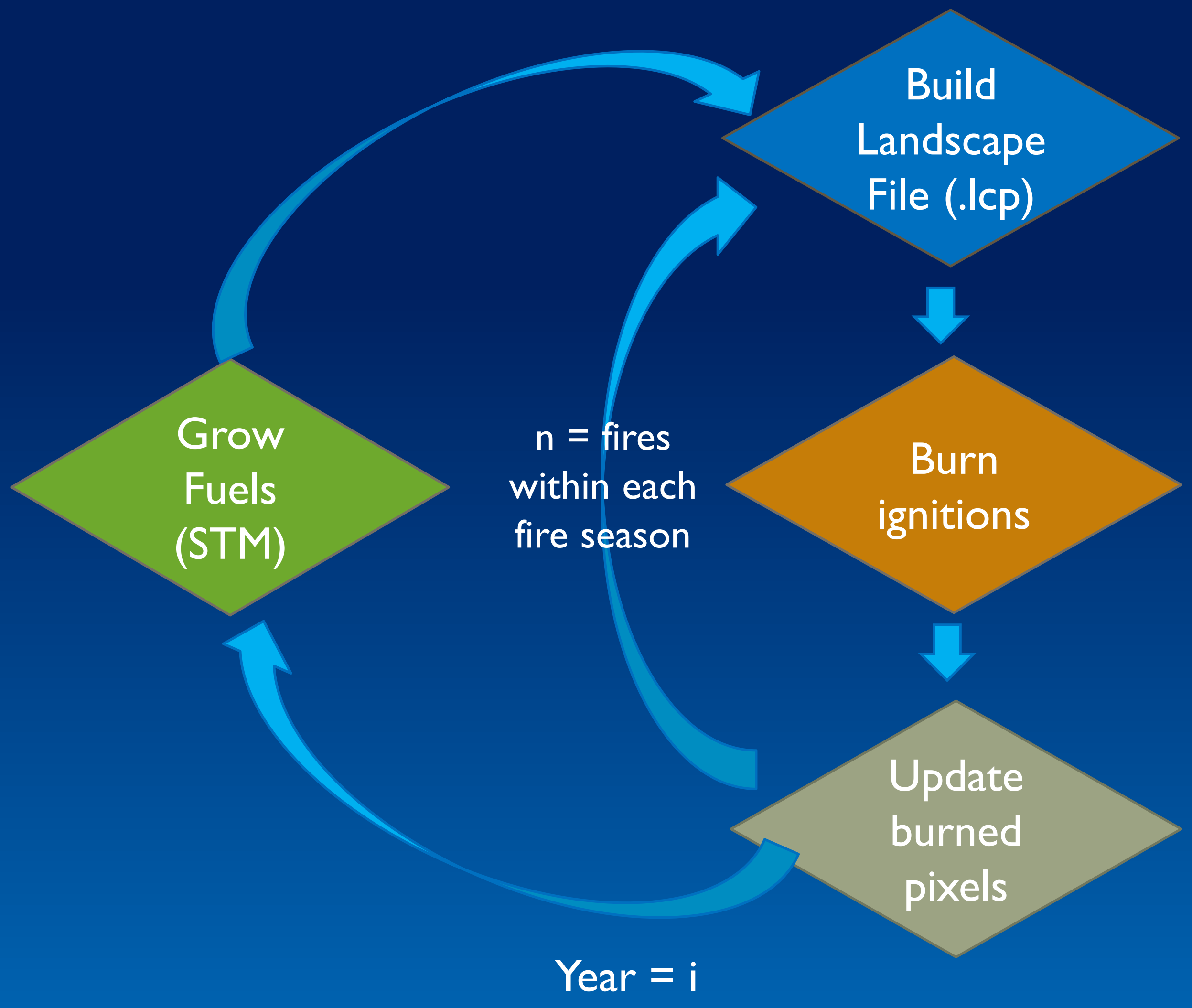


Severity Class
- High
- Moderate
- Low
- Unburned

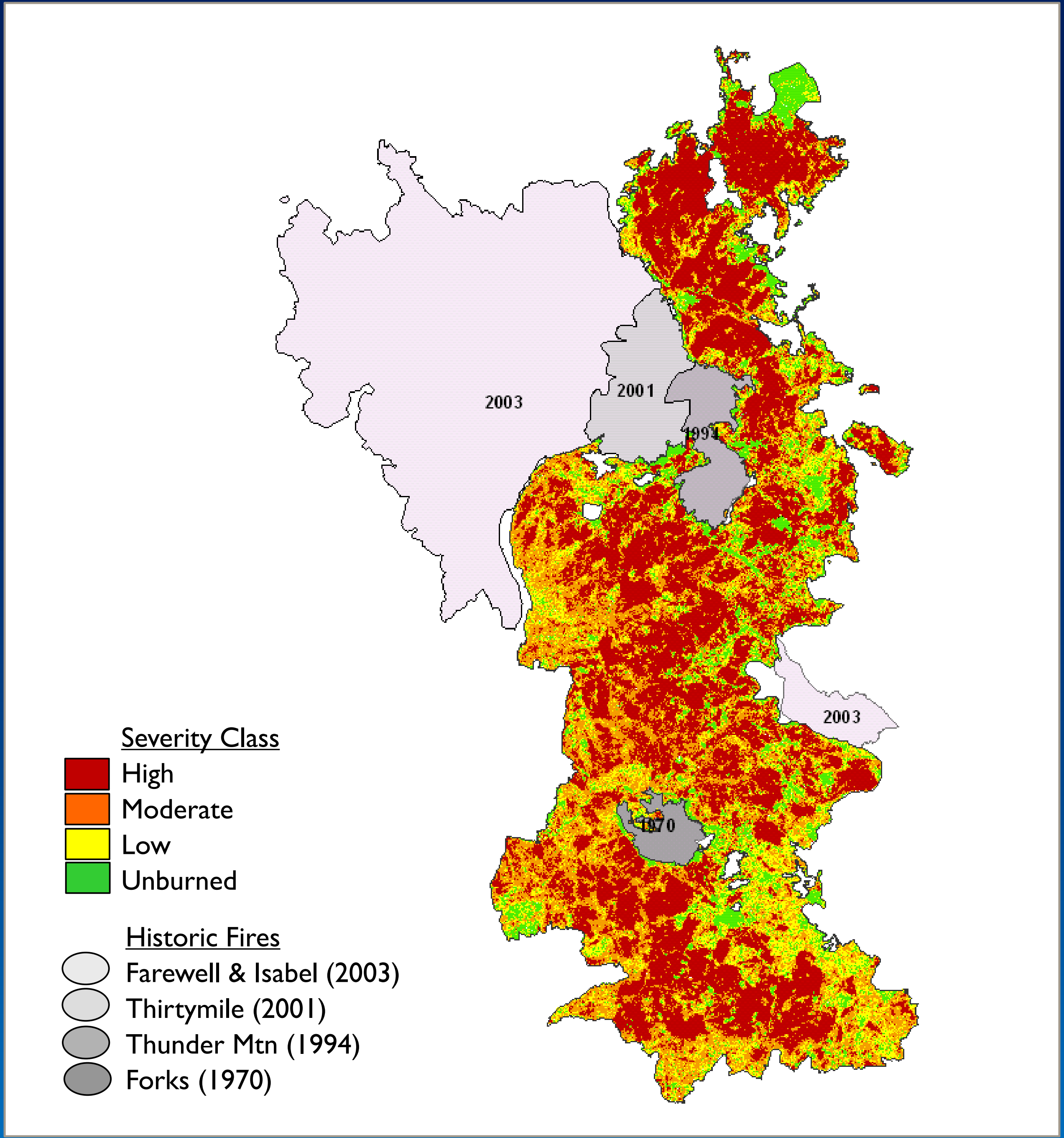
Fuel Treatments

Fuel Treatments

Task 2 – Spatial Simulation Modeling

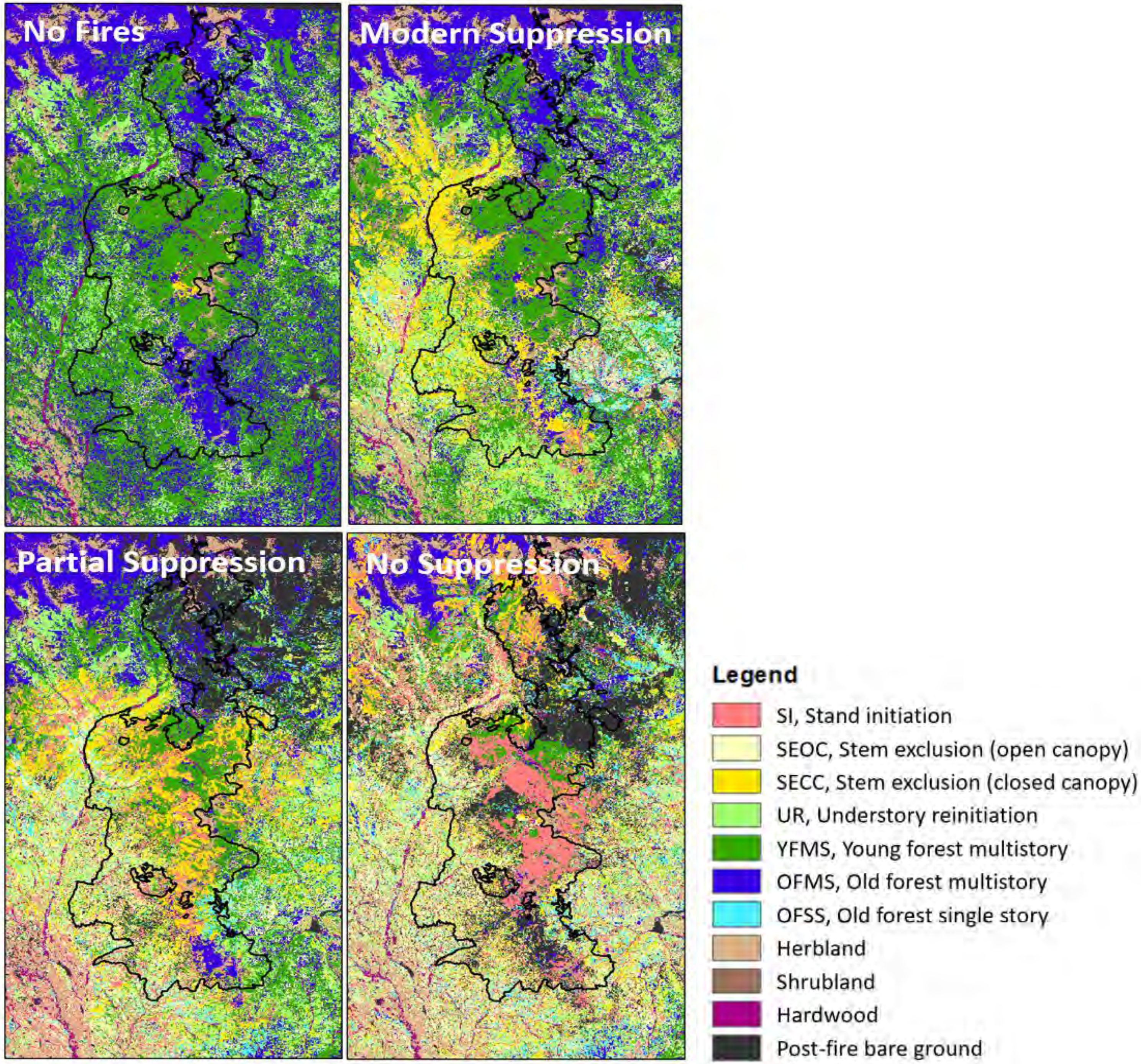


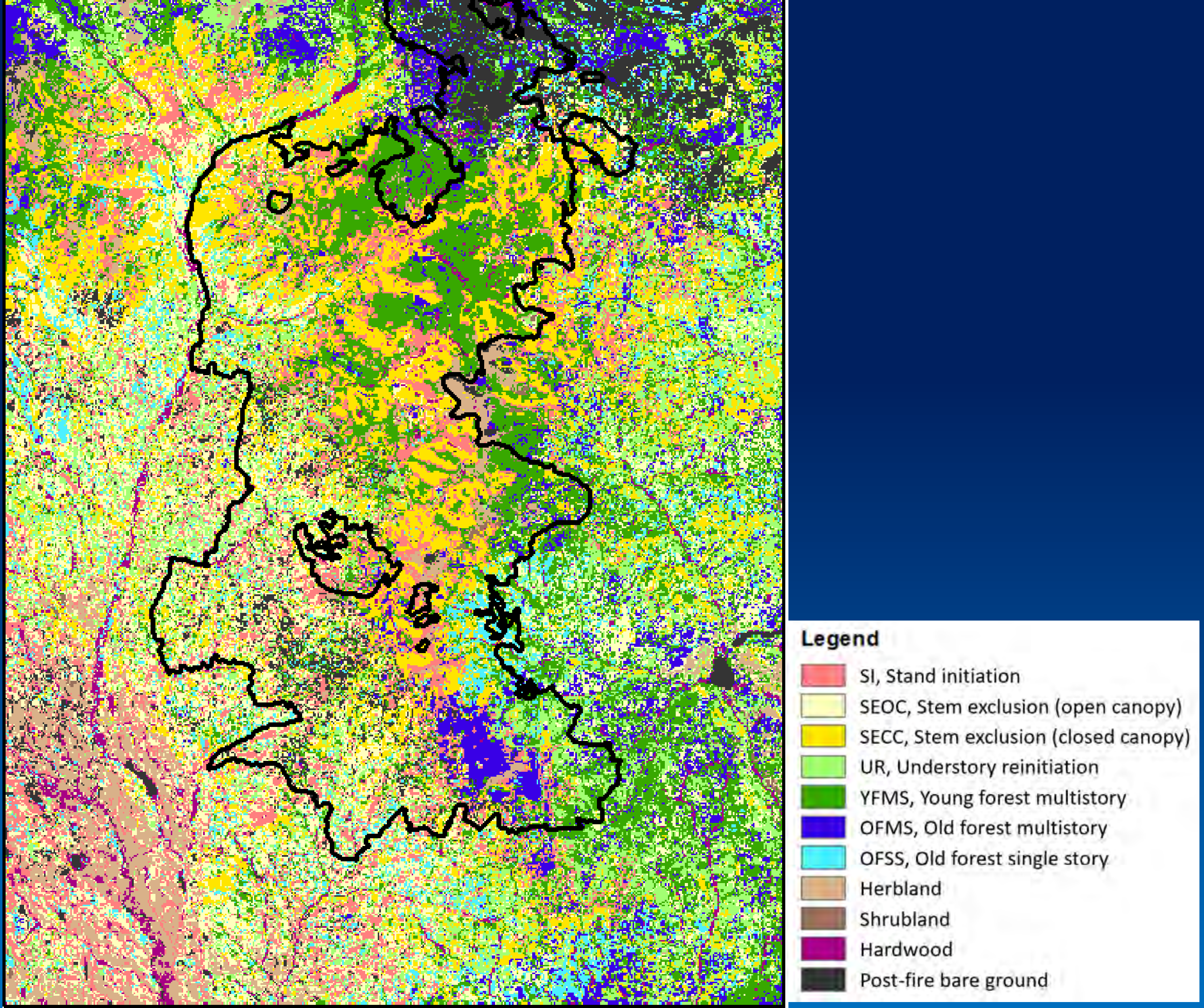
Task 2 used simulation modelling to evaluate alternatives to actual large wildfire events



Wildland Fire Management Scenarios

- **Complete absence of fire –** no ignitions
- **Modern Suppression –** only fires that escape suppression
- **Partial Suppression –** managed wildfires in the late-summer and fall fire seasons and escaped wildfires
- **No Suppression –** all ignitions that meet thresholds to burning


No Fires
Modern Suppression
Partial Suppression
No Suppression
Legend
SI, Stand initiation
SEOC, Stem exclusion (open canopy)
SECC, Stem exclusion (closed canopy)
UR, Understory reinitiation
YFMS, Young forest multistory
OFMS, Old forest multistory
OFSS, Old forest single story
Herbland
Shrubland
Hardwood
Post-fire bare ground


Legend
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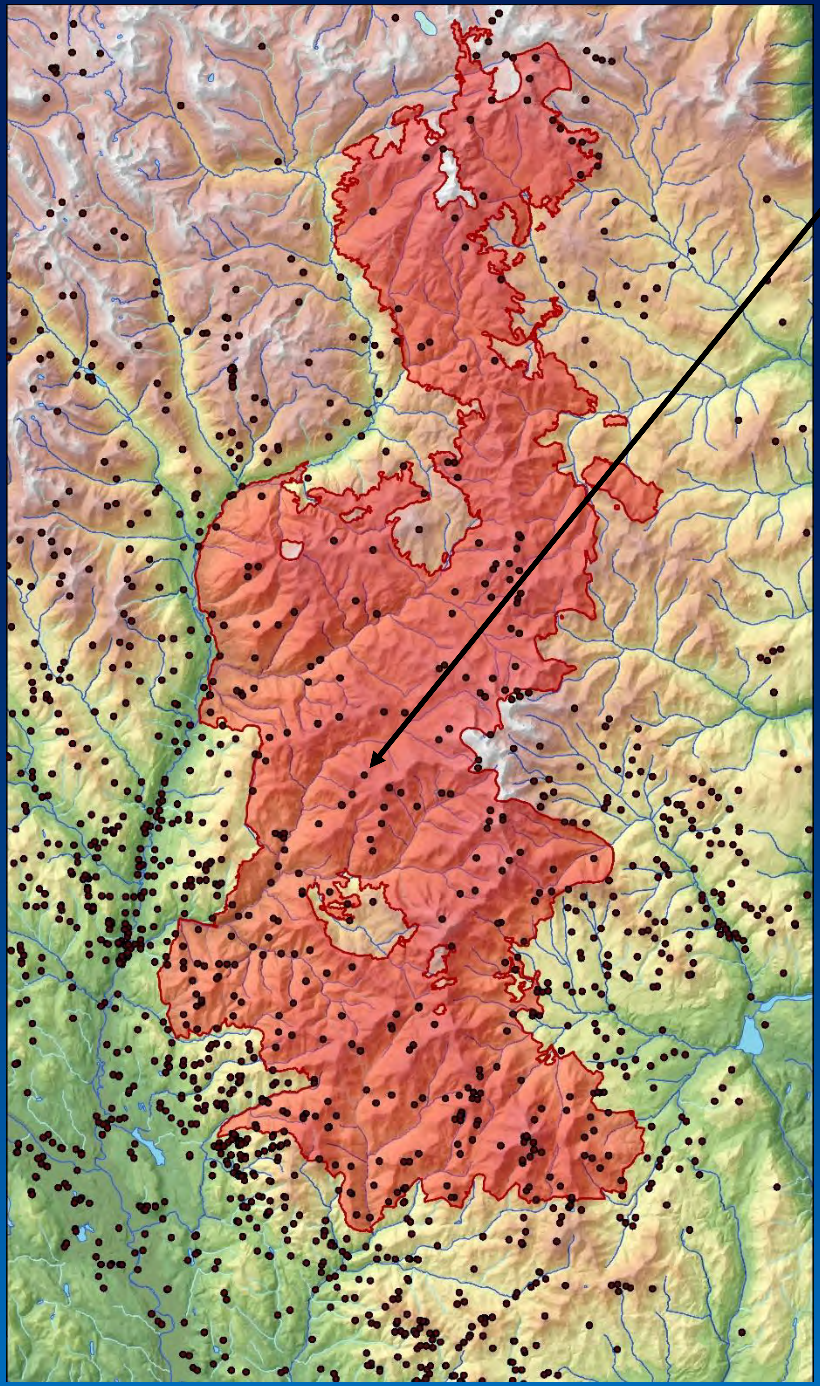
OFSS, Old forest single story
Herbland
Shrubland
Hardwood
Post-fire bare ground

Add zoom of let it burn scenario

State and Transition Model Development

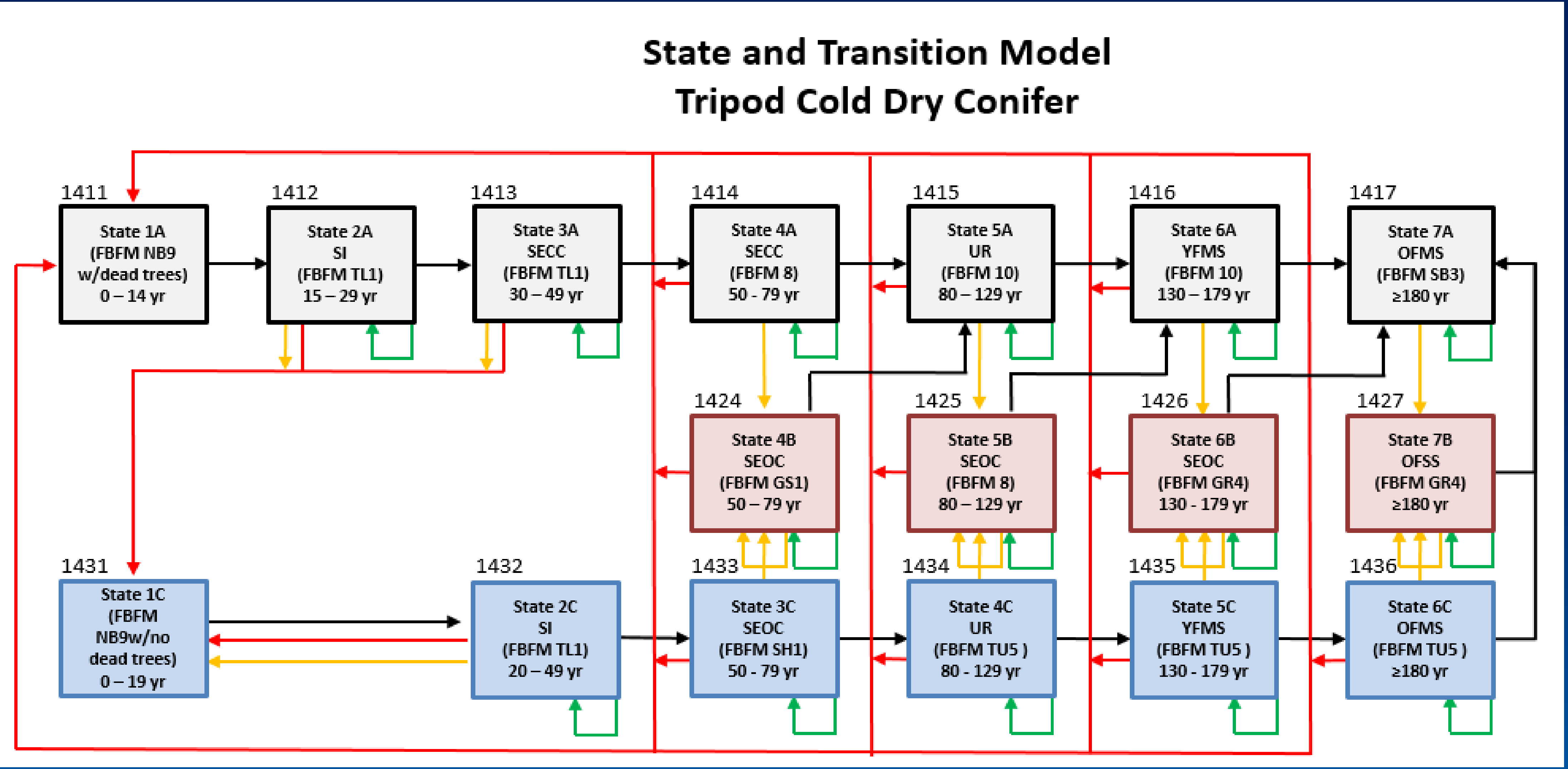
State and Transition Models of semi-arid forest landscapes in western North America: fire and fuel pathways

Authors:
Susan Prichard, Bob Gray, Paul Hessburg, Nicholas Povak, and Brion Salter



DMC Pixel burned 1940

- Assigned State 1A following fire season
- Add a time step prior to 1941
- In the absence of fire, this pixel will transition to State 2A in 1949.



State 2A
SI
(FBFM TL1)
10 – 29 yrs

→ Pathway
→ Stand structural class
→ Fire behavior fuel model
→ Length of time

State 2A
SI
(FBFM TL1)
10 – 29 yrs

- → **Pathway**
- → **Stand structural class**
- → **Fire behavior fuel model**
- → **Length of time**

Canopy fuels
Crosswalks to FCCS fuelbeds and habitat/carbon

Work with Brion on a table or graphic of how all STMs are in play on a landscape

Cold Dry Conifer STM – Exclusion Pathway

State 1A: Post-fire bare ground. Fuel model NB9. 0-14 yr.

State 2A: Stand initiation. Fuel model GS1. 15-49 yr.

State 3A: Stem exclusion closed-canopy. Fuel model 2. 50-89 yr.

State 4A: Understory reinitiation. Fuel model TU5. 90-129 yr.

State 5A: Young forest multi-story. Fuel model TU5. 130-179 yr.

State 6A: Old forest multi-story. Fuel model TU5. ≥ 180 yr.

Cold Dry Conifer STM – Reburn Pathway

State 1C: Post-fire bare ground. Fuel model NB9. 0-19 yr.

State 2C: Stand initiation. Fuel model TL1. 20-49 yr.

State 3C: Stem exclusion closed-canopy. Fuel model SH1. 50-89 yr.

State 4C: Understory reinitiation. Fuel model TU5. 90-129 yr.

State 5C: Young forest multi-story. Fuel model TU5. 130-179 yr.

State 6C: Old forest multi-story. Fuel model TU5. ≥ 180 yr.

Dry Mixed Conifer STM – Exclusion Pathway

State 1A: Post-fire bare ground. Fuel model NB9. 0-9 yr.

State 2A: Stand initiation. Fuel model GS1. 10-24 yr.

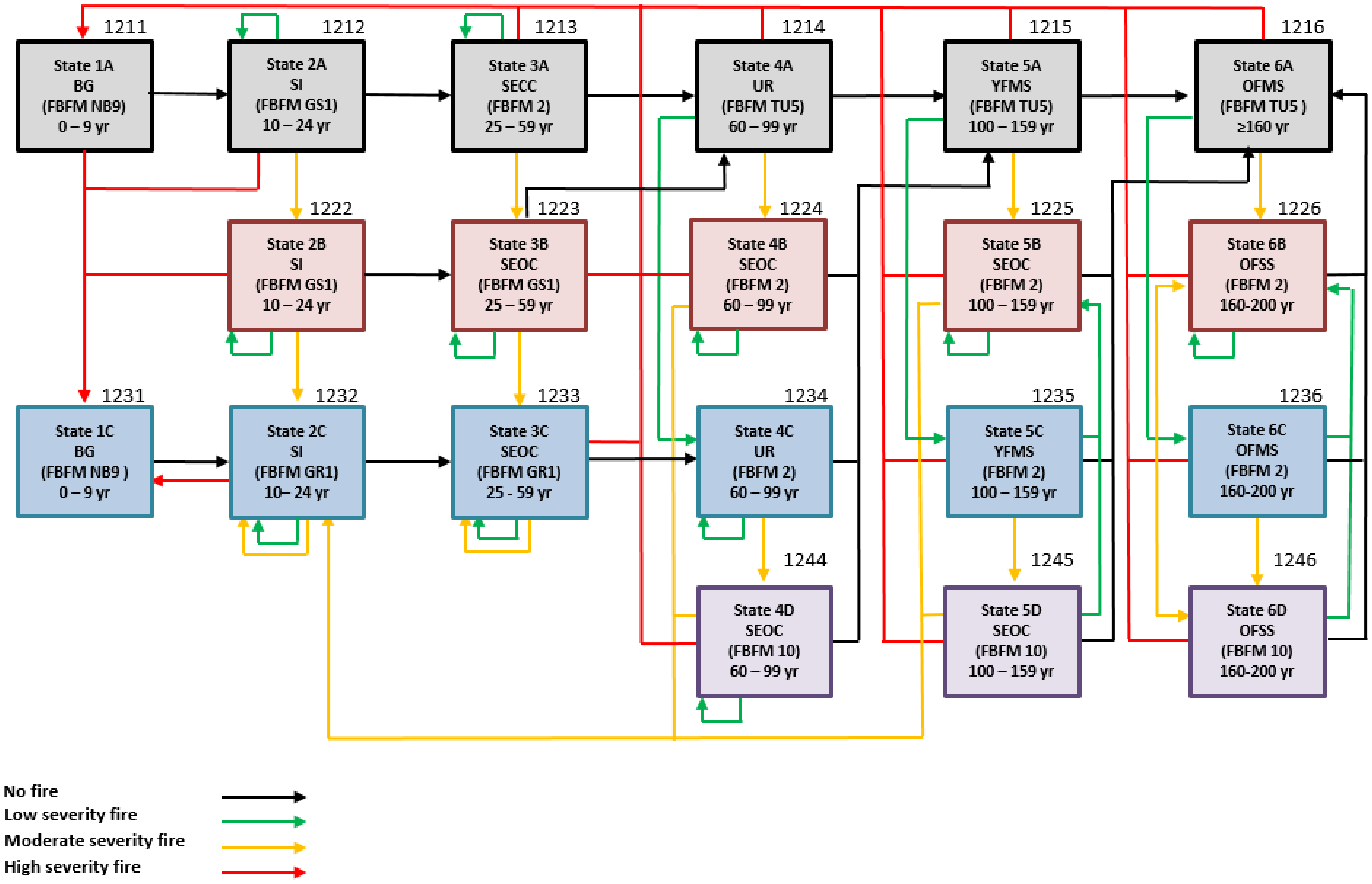
State 3A: Stem exclusion closed-canopy. Fuel model 2. 25-59 yr.

State 4A: Understory reinitiation. Fuel model TU5. 60-99 yr.

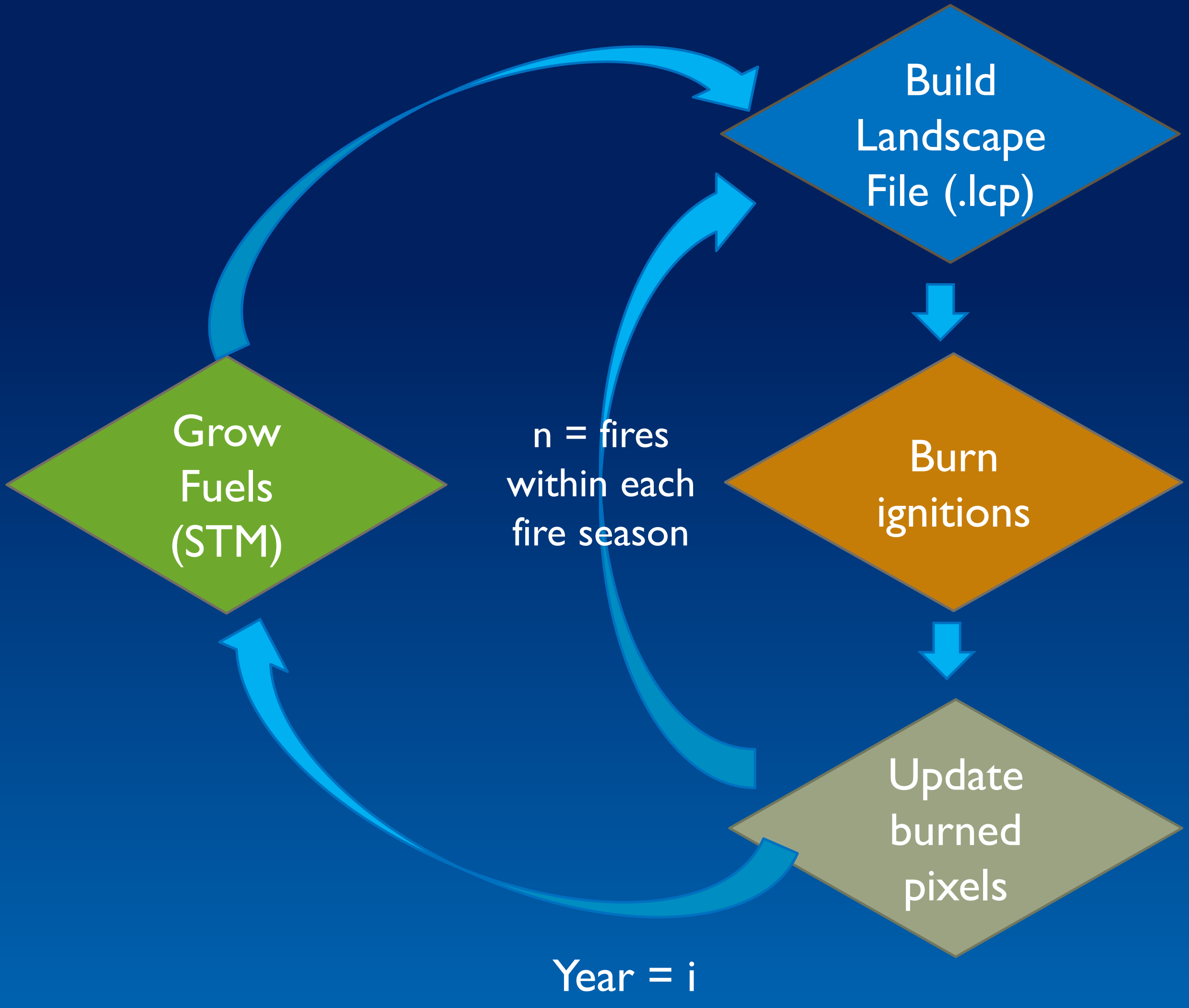
State 5A: Young forest multi-story. Fuel model TU5. 100-159 yr.

State 6A: Old forest multi-story. Fuel model TU5. 80-120 yr.

State and Transition Model
Tripod Dry Mixed Conifer Model



Spatial Simulation Modeling



Wildfire management scenarios – Simulation

We selected FSPro as our simulation model

- Standard use is to predict mid- to long-term fire behavior and extent given predicted weather

However, we used historical weather & ignition data (1940 – 2005)

- Calculated daily energy release component (ERC) streams from weather data
- Wind speed and direction from local weather stations
- US fire behavior fuel models (FBFM) – surface fuel loads
- Canopy cover, canopy bulk density, canopy base height
- Digital elevation model

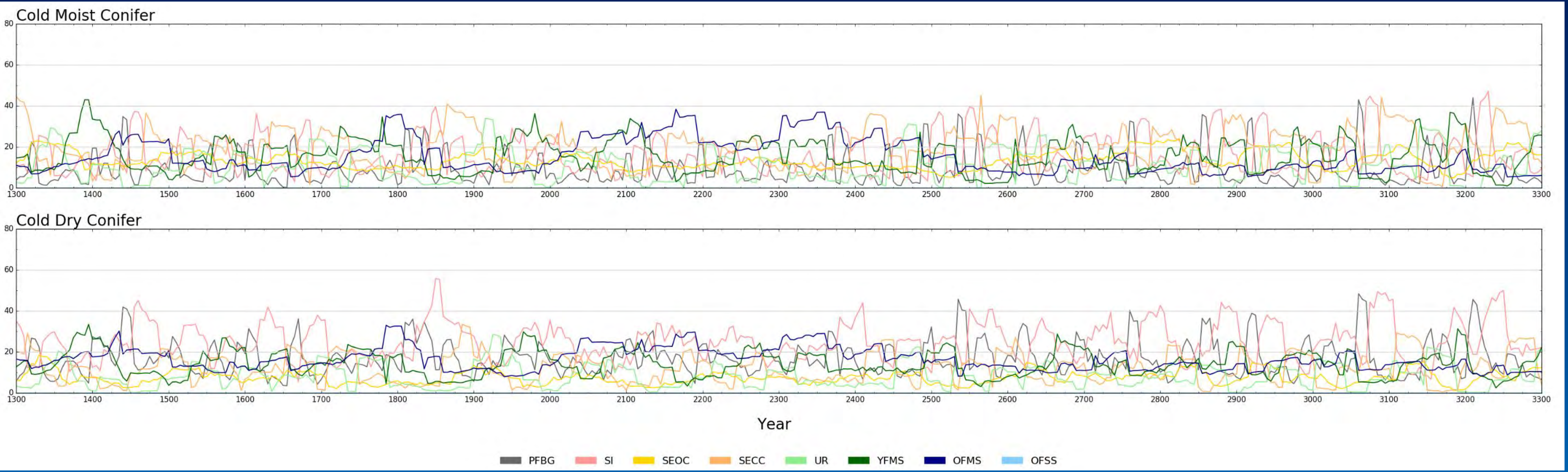
For each management scenario we:

- Started simulation with a simulated historical landscape
- Simulated each historical fire start
- Fires allowed to burn dependent on management scenario
- Stopped fire spread if consecutive days had low ERC (<55) to a 14 day max
- FSPro → fire extent → pixel-level flame length → fire severity → change in state

Wildfire management scenarios – Simulation

We used simulation process to model long-term ecosystem change:

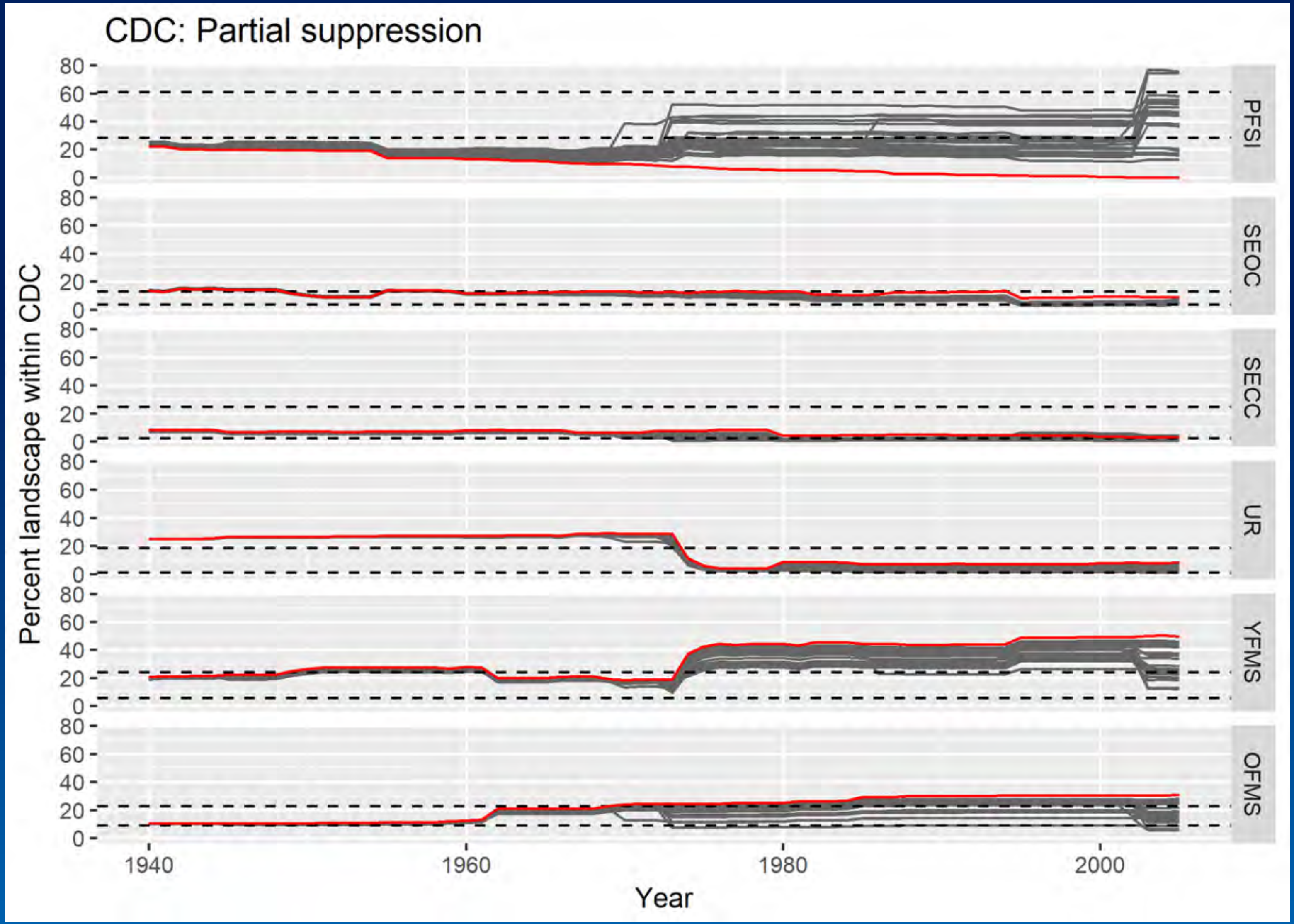
- Developed representations of "natural" landscapes developed under intact fire regime
- Used to assess historical range of variation (HRV), defined as percent of landscape in each forest structure type



Wildfire management scenarios – Simulation

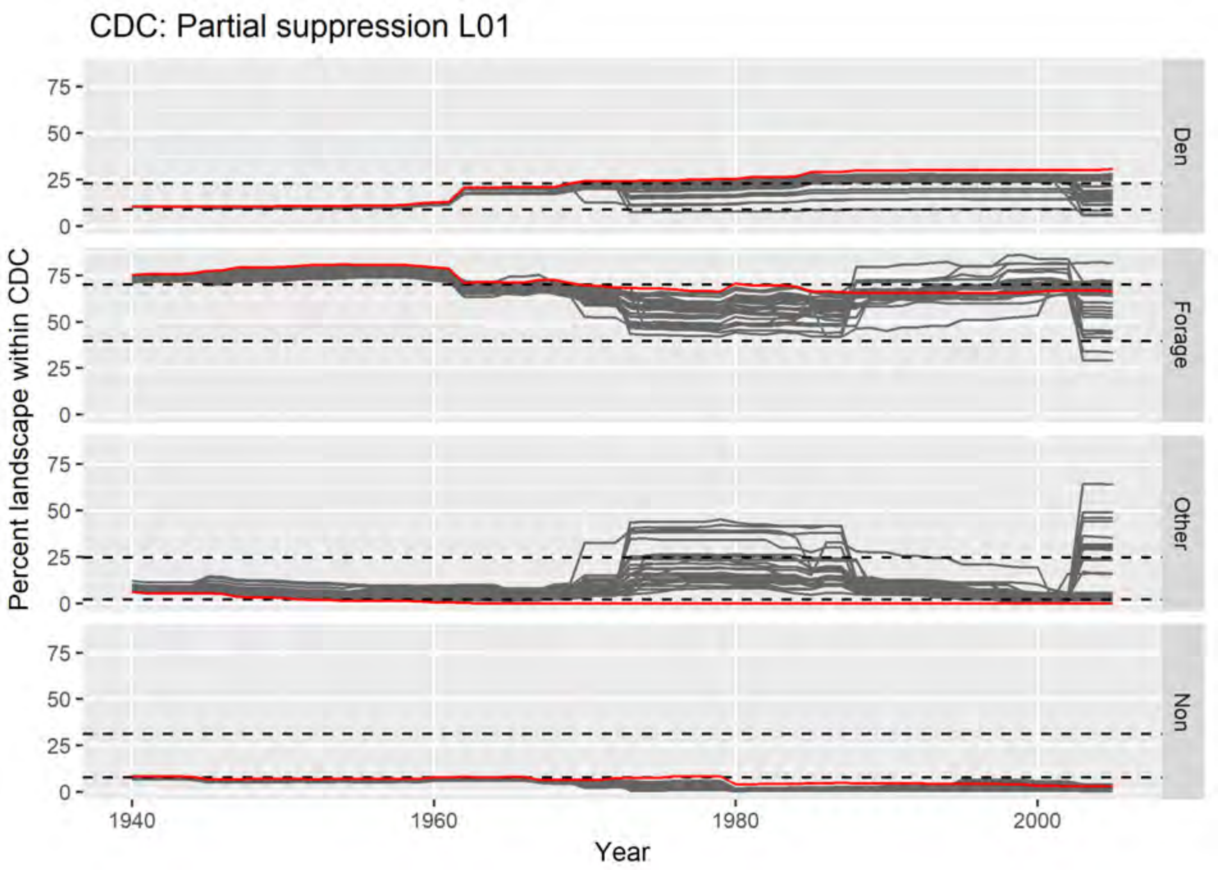
Compare results from management scenarios to HRV – dashed horizontal lines

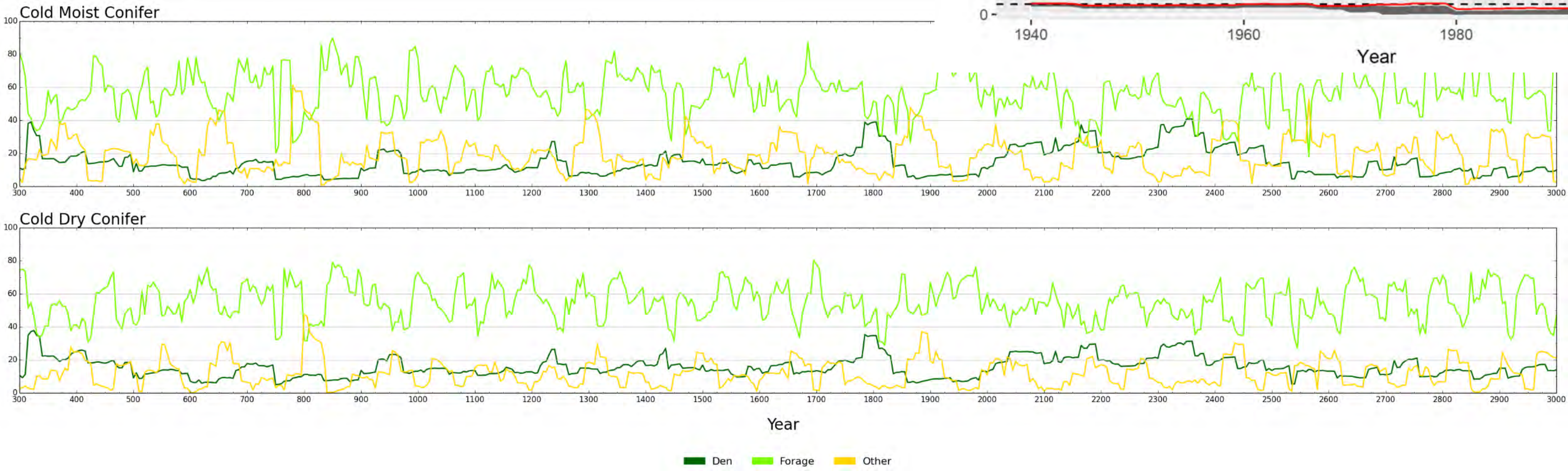
- Red line – no fires burned
- Grey lines 25 iterations of model simulation



Landscape assessments

- Wildlife habitat (Canada lynx)
- Biomass
- Carbon





Management Applications

1) Active wildfire management – use of patch mosaics in suppression operations and managed wildfires

2) Implications of wildland fire management scenarios for wildlife habitat (e.g., Canada Lynx)

3) Climate change – evaluating resilience of landscapes

4) Carbon storage – carrying capacity of landscapes under varying wildfire scenarios

Applications to Cariboo-Chilcotin landscape

Not just wildfires

1) Bark beetle dynamics interacting with wildfire disturbances
2) Multiple BB species with associated ecosystem response and spread potential
3) Ecosystem effects differ between BB and fire
4) Canopy and surface fuels

Not just forest structure

1) Carbon dynamics
2) Salvage potential
3) Reburn potential
4) Options for initial attack
5) Options for restoration treatments