Historical Range of Variability and Alternative Management Scenarios in the Yuba River Watershed, Tahoe National Forest, California

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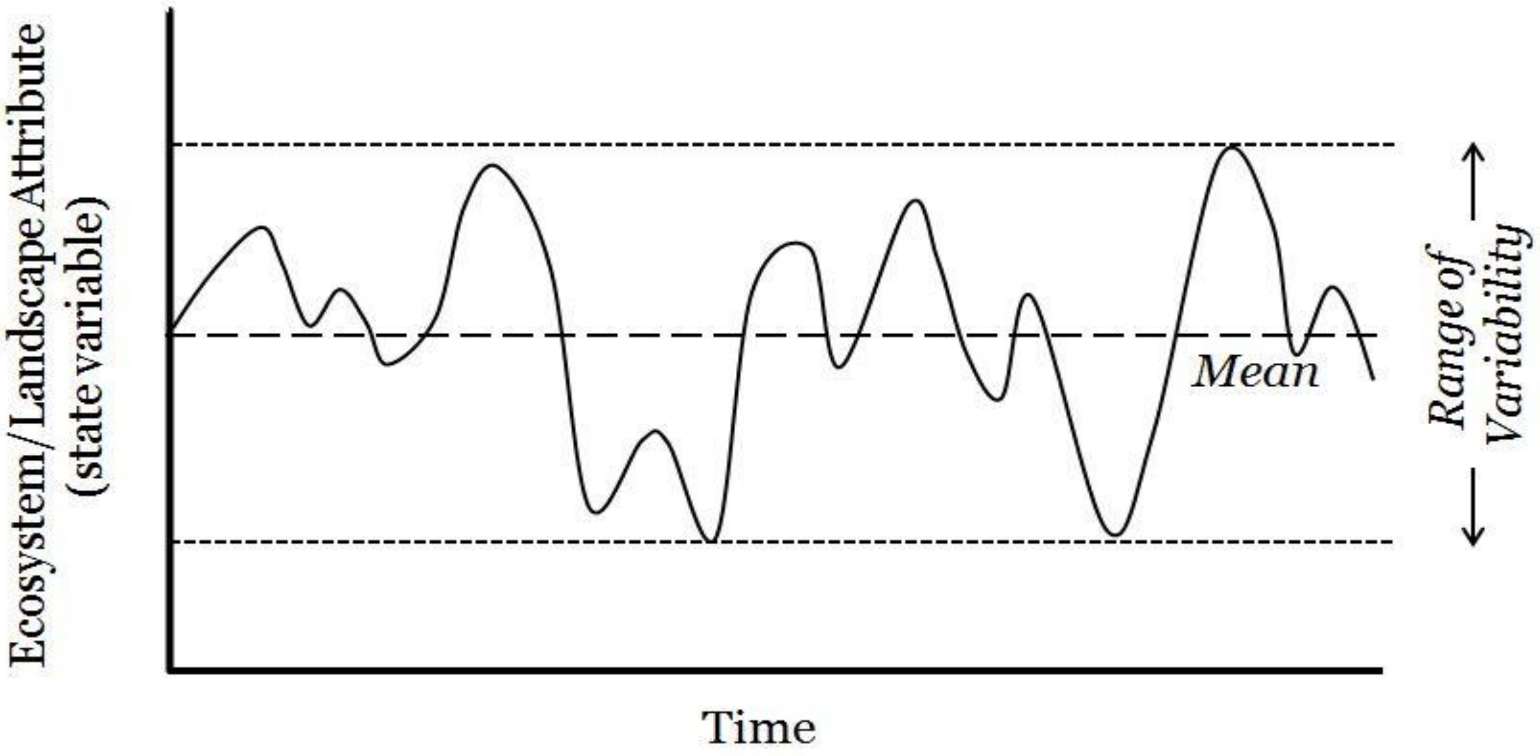
Introduction

Why use the Range of variability (ROV) concept?



Ecosystems/landscapes are in a constant state of change driven by spatial and temporal variability in ecological processes such as disturbance and succession

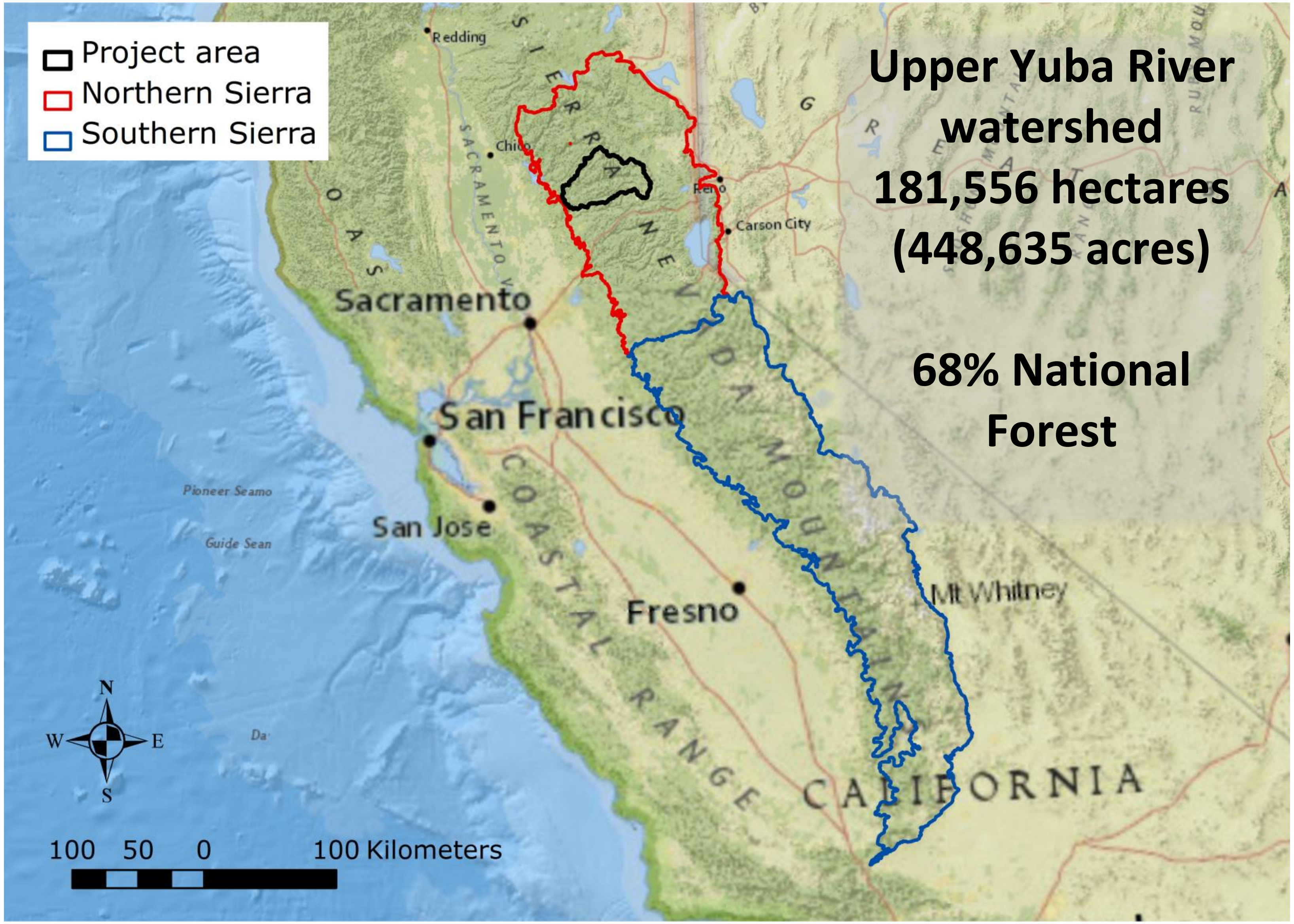
Introduction

Objectives

1. Synthesize empirical and expert knowledge on disturbance and succession processes characteristic of the pre-Euro-American settlement period in the ecoregion containing the Upper Yuba River watershed.
2. Quantify the HRV in landscape structure (i.e., vegetation land cover composition and configuration) in the Upper Yuba River watershed using the RMLands landscape disturbance-succession model.
3. Quantify the current departure of the Upper Yuba River watershed landscape structure from its HRV.
4. Quantify the range of variability in landscape structure in the Upper Yuba River watershed under several alternative potential management scenarios and compare them to the current landscape and HRV.
5. Synthesize the simulation modeling results and summarize the implications for land management.

Introduction

Project area



Upper Yuba River watershed
181,556 hectares (448,635 acres)

68% National Forest

Introduction

Historical range of variability (HRV)

- We chose HRV for the 300 years prior to Euro-American settlement (circa 1550-1850) to represent the Natural Range of Variability (pursuant to the Forest Planning Rule)

  - Several times the length of fire rotation periods for well-understood cover types within project area and a time frame for which we have sufficient information to have some confidence in model results
  - Sufficient to capture notable variability in landscape structure
  - Allow managers to base near-term plans and expectations within a broader temporal context
  - Allows us to compare current conditions to a baseline set of data on ecosystem conditions that represent a hypothesis of the state of the landscape when Euro-Americans arrived.

Introduction

Landscape Disturbance-Succession Models

- We chose to use a dynamic landscape simulation model (RMLands) to quantify ROV

Landscape Disturbance-Succession Models (**LDSMs**) are one class of models that have broad applicability for quantifying ROV

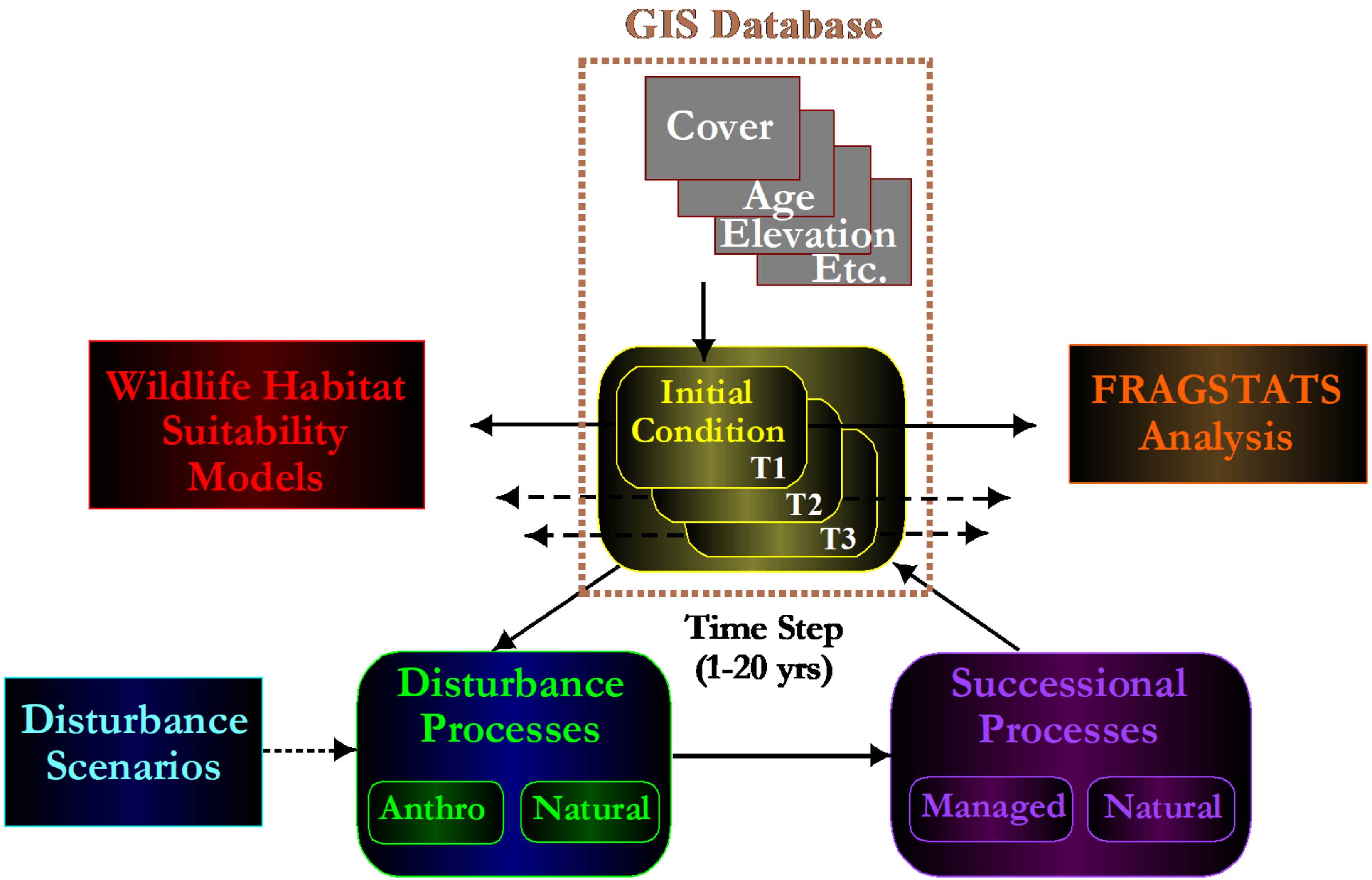
Introduction

Landscape Disturbance-Succession Models

- **Succession...** establishment and growth of tree species or communities
- **Disturbance...** modification of species or communities by disturbance

Methods

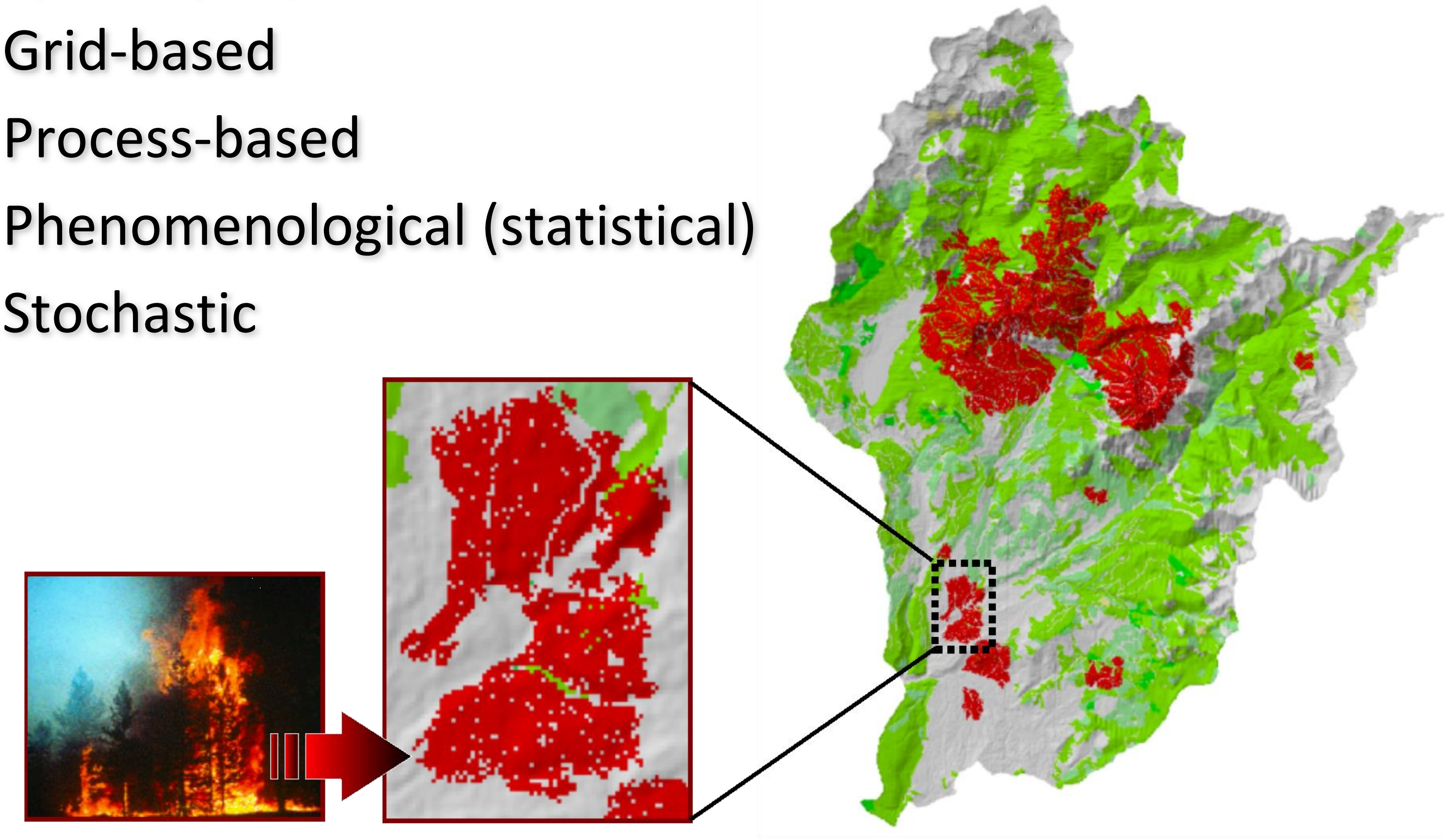
RMLands overview



Methods

RMLands key features

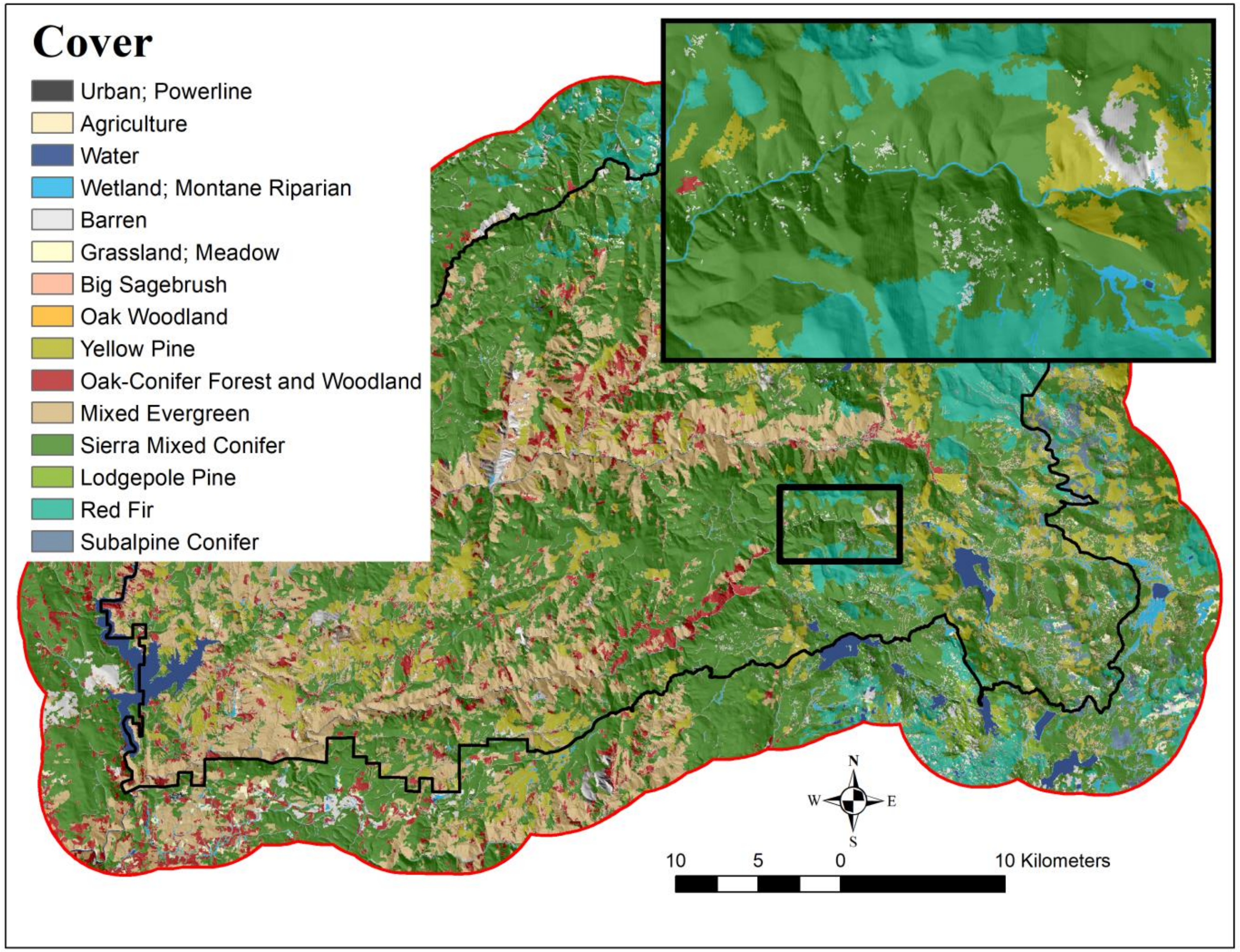
- Spatially explicit
- Grid-based
- Process-based
- Phenomenological (statistical)
- Stochastic



Methods

RMLands key input layers

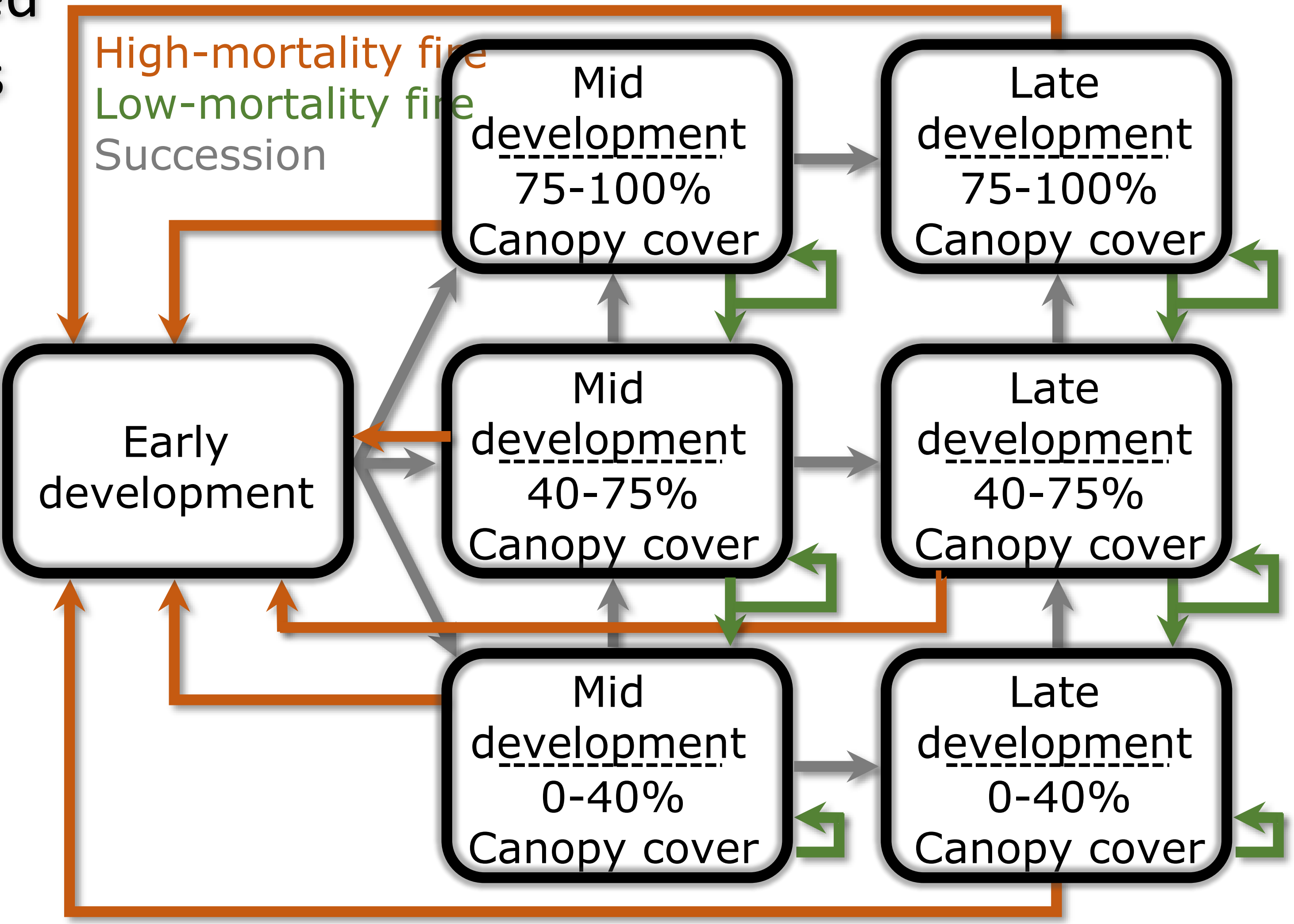
- Cover type
- Seral stage (developmental stage & canopy cover)
- Age
- Terrain (elevation, aspect, slope, topographic position)
- …



Methods

RMLands succession

- State-based transitions
- Branching pathways
- Stochastic



Methods

HRV model parameterization

Model parameterization refers to the assignment of values (coefficients) to each of the parameters that govern the model processes (e.g. succession and disturbance):

- Based on a combination of empirical observations, estimates from statistical models, and expert opinion.
- Most parameters were treated as fixed while a few were arbitrary and adjusted during model calibration.

Methods

HRV model calibration

Model calibration refers to the adjustment of model parameters to achieve certain quantitative and qualitative target outputs, with the following considerations:

- Targets were restricted to the disturbance regime drivers, not the vegetation response.
- Calibration was mostly by trial and error adjustment of parameters ("tune" or "tweak") via many iterations to get match between simulated outputs and measured/observed values.

Methods

HRV model calibration

Cover Type	Target Rotation
Curl-leaf Mountain Mahogany[2]	76
Lodgepole Pine[1]	52
Lodgepole Pine with Aspen[1,4]	52
Mixed Evergreen – Mesic[2,5]	50
Mixed Evergreen – Xeric[2,5]	40
Mixed Evergreen - Ultramafic[2,3]	120
Montane Riparian[2]	53
Oak Woodland[1]	26
Oak-Conifer Forest and Woodland[1]	21
Oak-Conifer Forest and Woodland – Ultramafic[1,3]	42

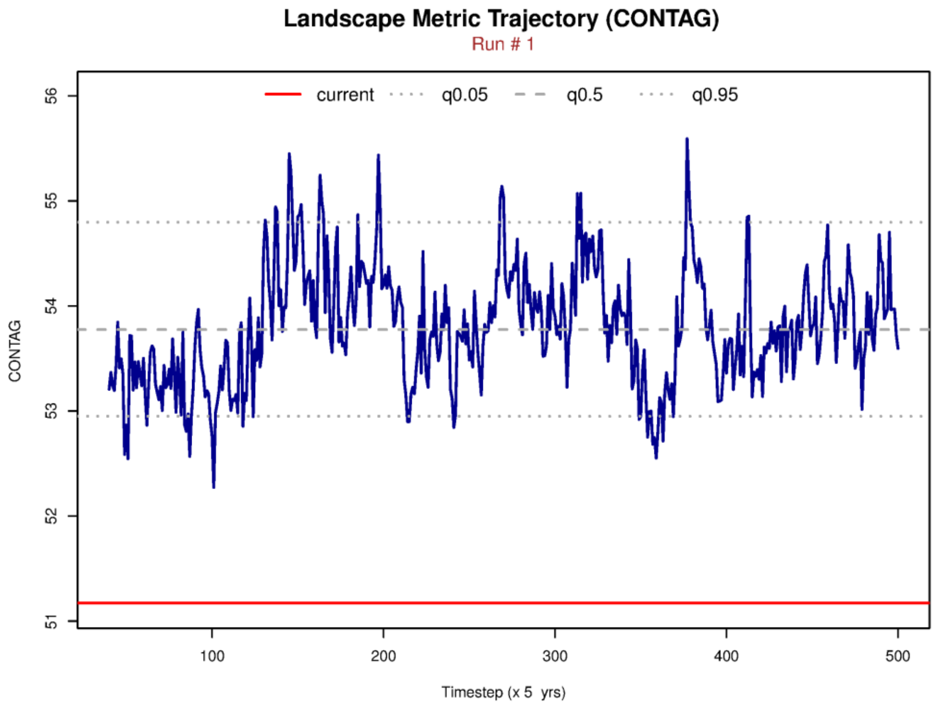
Cover Type	Target Rotation
Red Fir – Mesic[1,6]	60
Red Fir – Xeric[1,6]	40
Red Fir - Ultramafic[1,3]	120
Red Fir with Aspen[1,4]	60
Subalpine Conifer[1]	296
Sierran Mixed Conifer – Mesic[1]	29
Sierran Mixed Conifer – Xeric[1]	22
Sierran Mixed Conifer - Ultramafic[1,3]	60
Sierran Mixed Conifer with Aspen[1,4]	29
Western White Pine[2]	88

[1]Mallek et al. 2013: LPN, OAK, OCFW, RFR, RFR, SCN, SMCM, SMCX, YPN
[2]Van de Water and Safford 2011: shrub types, MEG, MRIP, WWP
[3]Expert opinion: double values from Mallek et al (OCFW, RFR, SMC) or VDW&S(MEG) to get to ultramafic
[4]Expert opinion: use mesic/regular value for aspen variant
[5]Expert opinion used to modify VDDT values for MEG into differentiated values for MEG
[6]Expert opinion used to assign differentiated FRIs to mesic vs. xeric variants of RFR

Methods
HRV scenario

- 5 year timesteps
- Single 500 timestep (2,500 years) simulation run
- 40 timestep (200 year) equilibration period

N = 460 landscape snapshots representing HRV



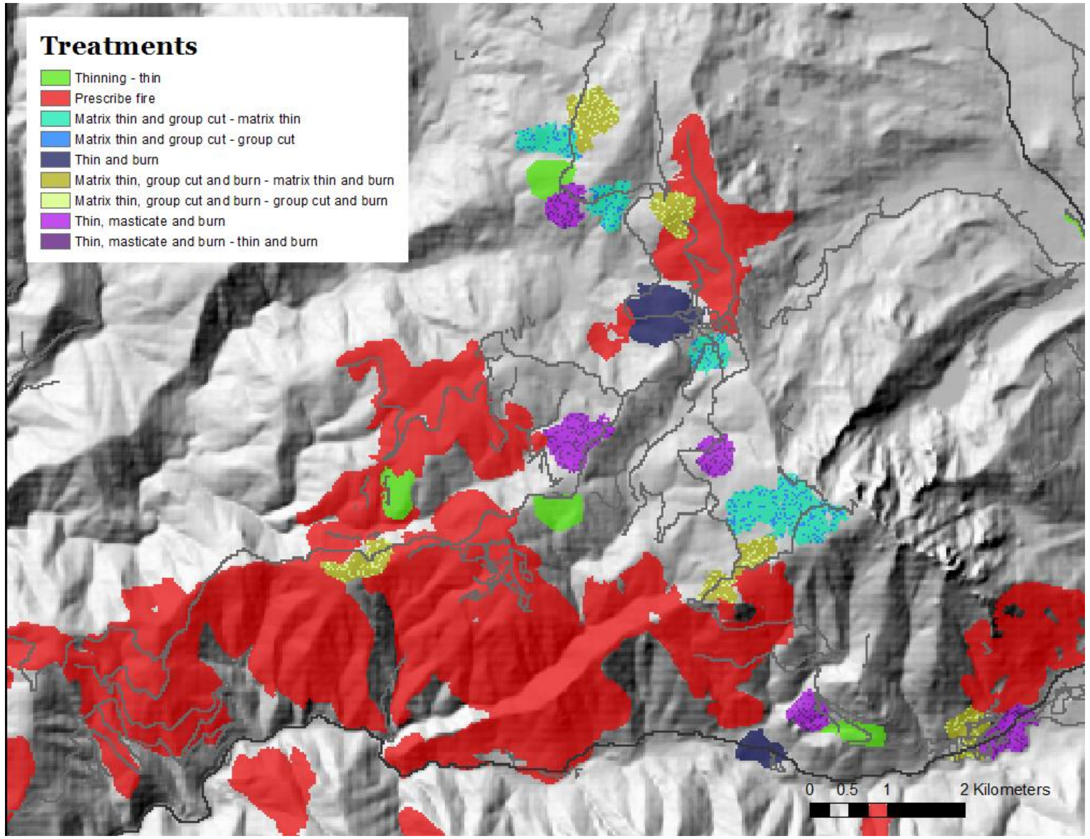
Note, despite the length of the simulation, the HRV still represents the historical reference period of 1550-1850

Methods

Management scenarios

- 5 year timesteps
- 20 replicate 20 timestep (100 years) simulation runs
- Kept last timestep of each simulation

N = 20 landscape snapshots representing the ROV



Treatments were subject to a variety of realistic spatial and temporal constraints

Methods

Management scenarios

MS1: no treatment — [0 ha/5 years]

MS2: current LMP — Mechanical [3,458 ha (2.8%)/5 yrs]

MS3a: Rx fire only — cool burns [34,191 ha (27.6%)/5 yrs]

MS3b: Rx fire only — hotter burns [same]

MS4: LMP higher (5x) intensity — [15,572 ha (12.6%)/5 yrs]

MS5: SNC — Rx fire [30,798 ha (24.8%)/5 yrs]

MS6: "balanced" — Rx fire & mech [24,198 ha (19.5%)/5 yrs]

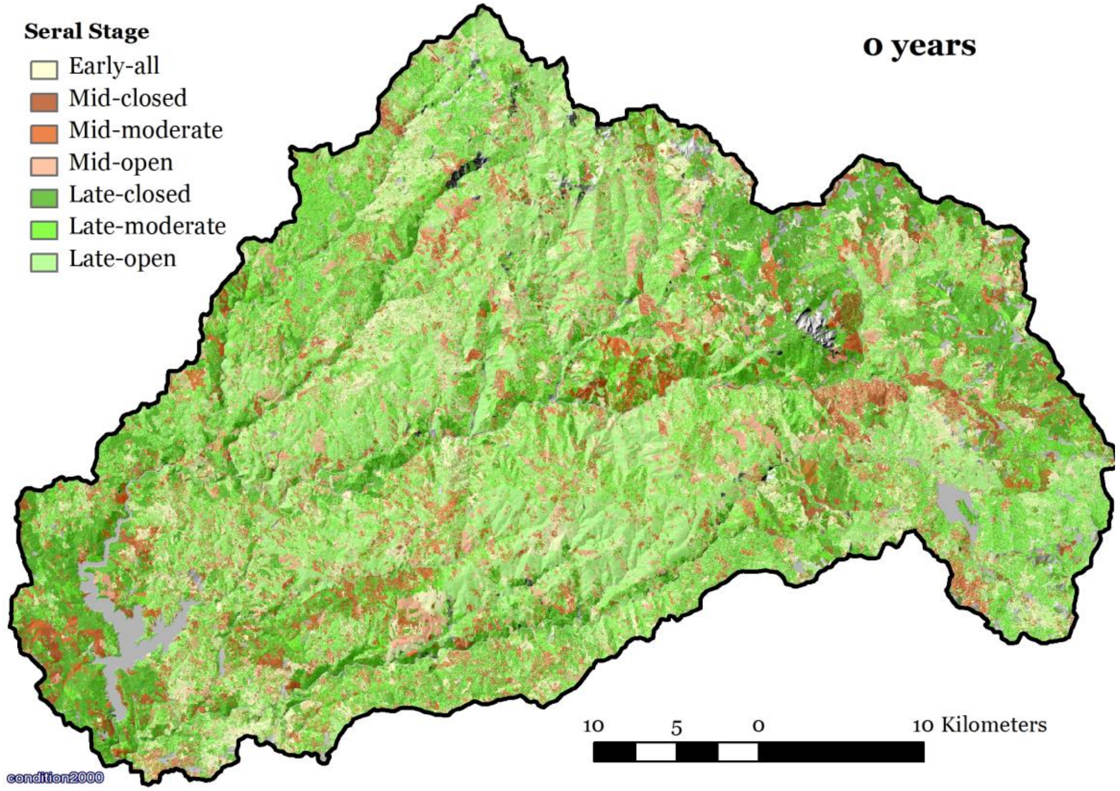
MS7: "final" — emulate HRV [22,174 ha (17.9%)/5 yrs

*all scenarios were subject to the forcings of a modern wildfire regime (~152 yr FRP)

Major Findings

1. The study landscape during the historical reference period was best characterized as a shifting mosaic of vegetation types and conditions.

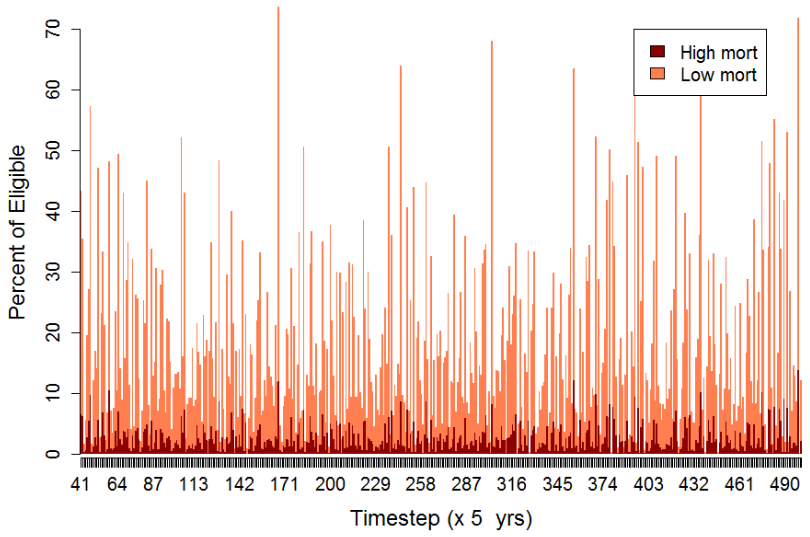
- Illustrates the dynamic nature of the landscape to the public
- Communicating this is important because it builds understanding and support for disturbance (natural and anthropogenic) as a positive force for maintaining resilient landscapes



Major Findings

2. During the historical reference period the study landscape was subject to a remarkably high wildfire disturbance rate.

- 18% (~30,000 ha/74,000 acres of the 174,830 ha/432,014 acres eligible) on average burned every 5 years
- Varied dramatically over time, ranging from <1% (~100 ha/247 acres) to almost 74% (~129,000 ha/319,000 acres)
- Average/year = 3.5%

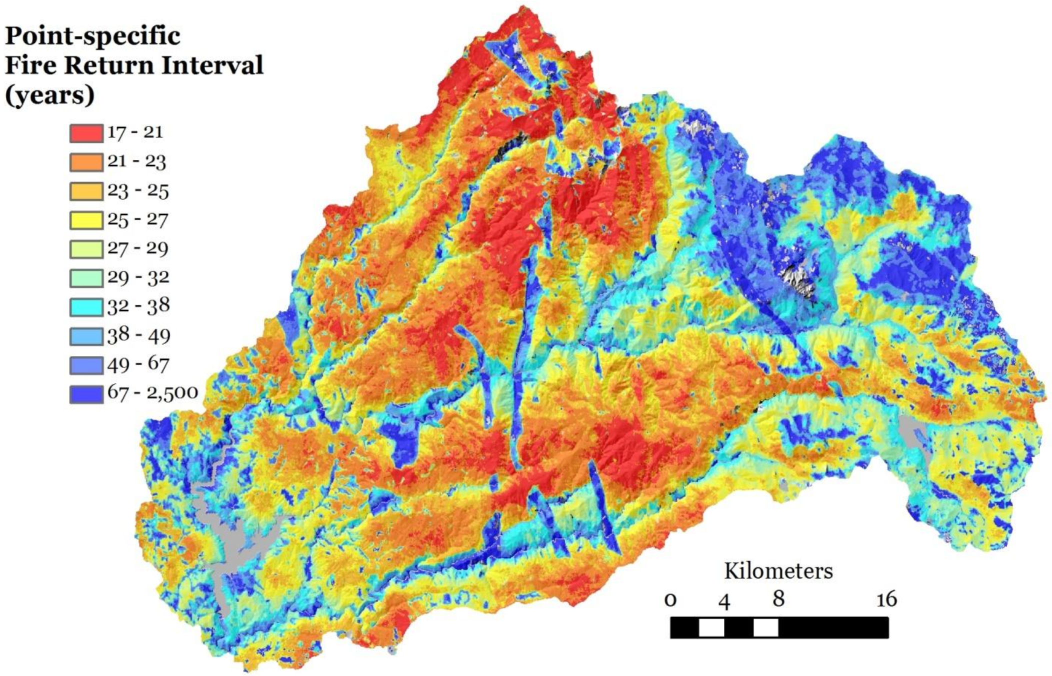


- 63% chance of burning >10% of the eligible landscape every 5 years
- 4% chance of burning >50% of the landscape every 5 years

Major Findings

2. During the historical reference period the study landscape was subject to a remarkably high wildfire disturbance rate.

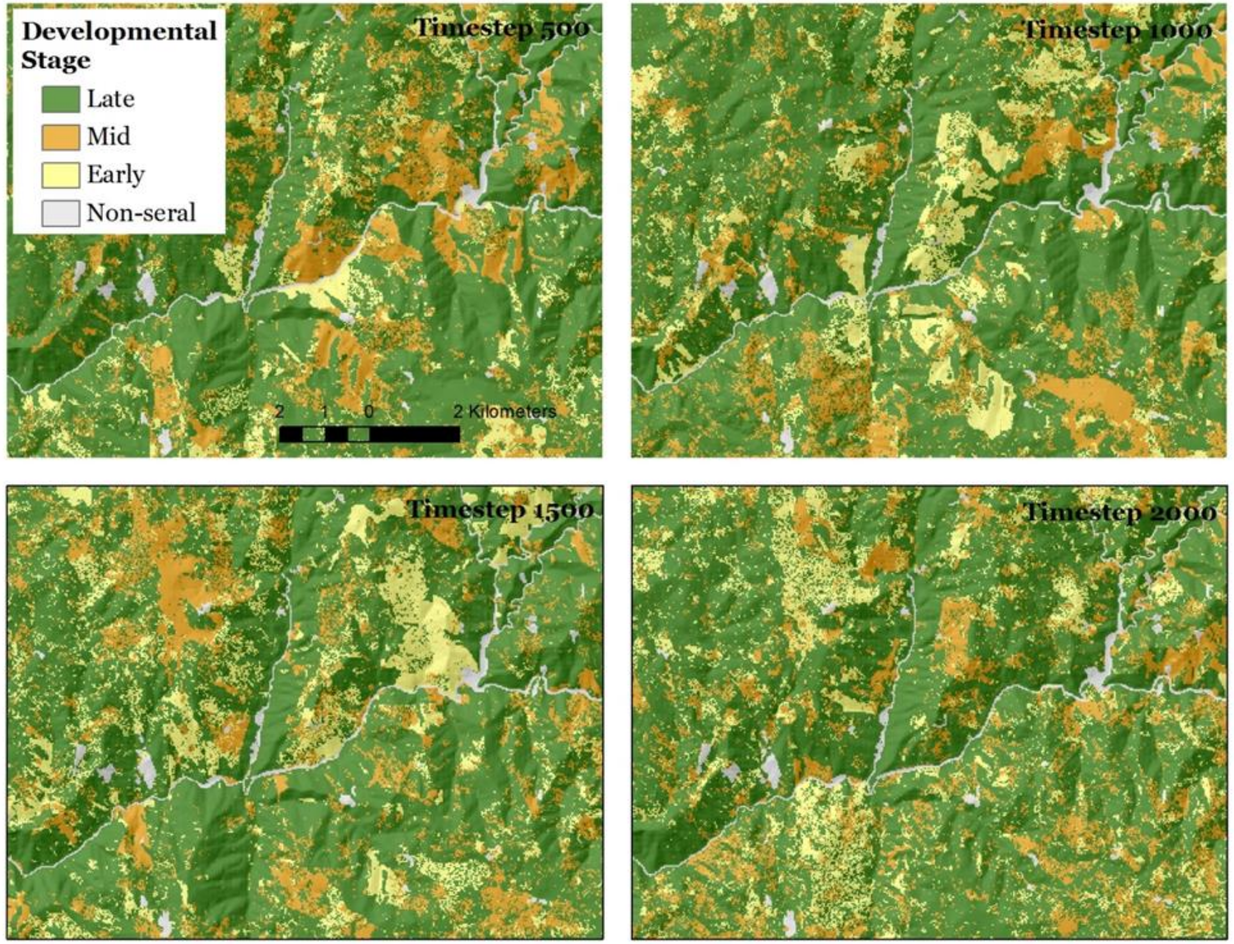
- Overall Fire Rotation Period (FRP) = 29 years
- Varied dramatically over space as illustrated by the point-specific Fire Return Interval (FRI), reflecting variation in vegetation and terrain



Components of Landscape Structure

Landscape Composition – The variety and abundance of landscape elements (non-spatial component)

Landscape Configuration – The spatial characteristics and distribution of landscape elements (spatial component)

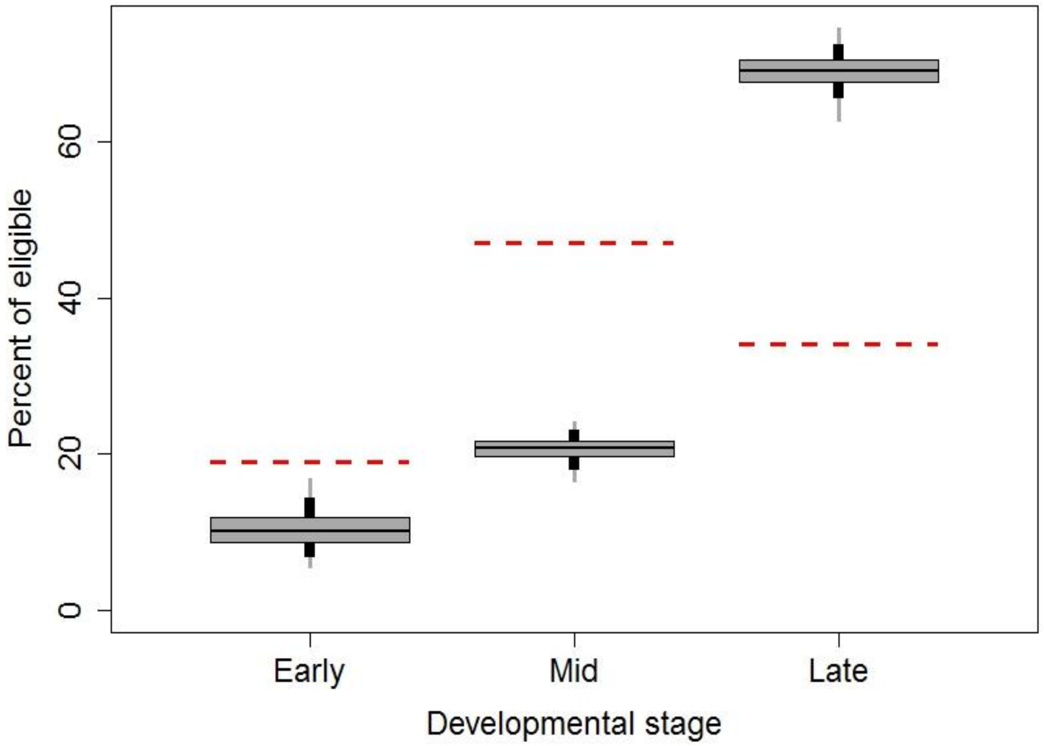


Major Findings

3. The current landscape departs from the historical range of variability in the composition of vegetation mosaic, and more in some attributes than others.

- HRV: 10:20:70 ratio of early:mid:late developmental stages
- Current landscape departs dramatically

- ↓early & mid, ↑late
- Time, facilitated by fuels management and thinning to promote diameter growth

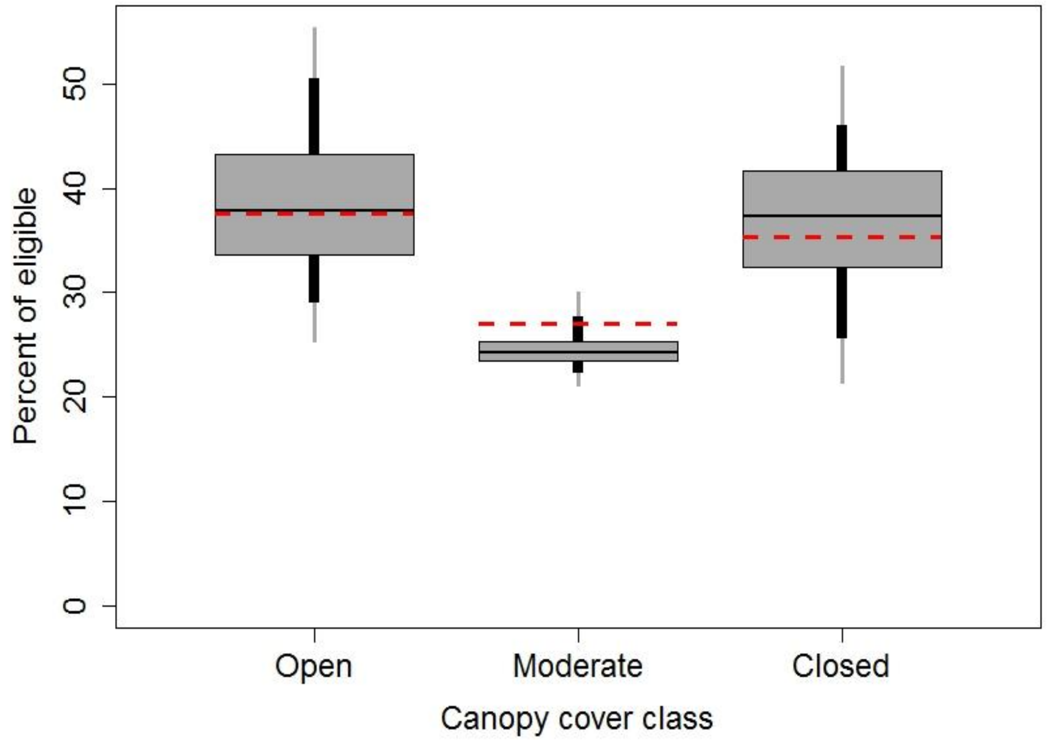


*pooled across cover types

Major Findings

3. The current landscape departs from the historical range of variability in the composition of vegetation mosaic, and more in some attributes than others.

- HRV: 38:24:37 ratio of open:moderate:closed canopy cover classes
- Current landscape within HRV (when pooled across cover types)
- Driven by excess of early development (open) and masking important differences among cover types and within developmental stages



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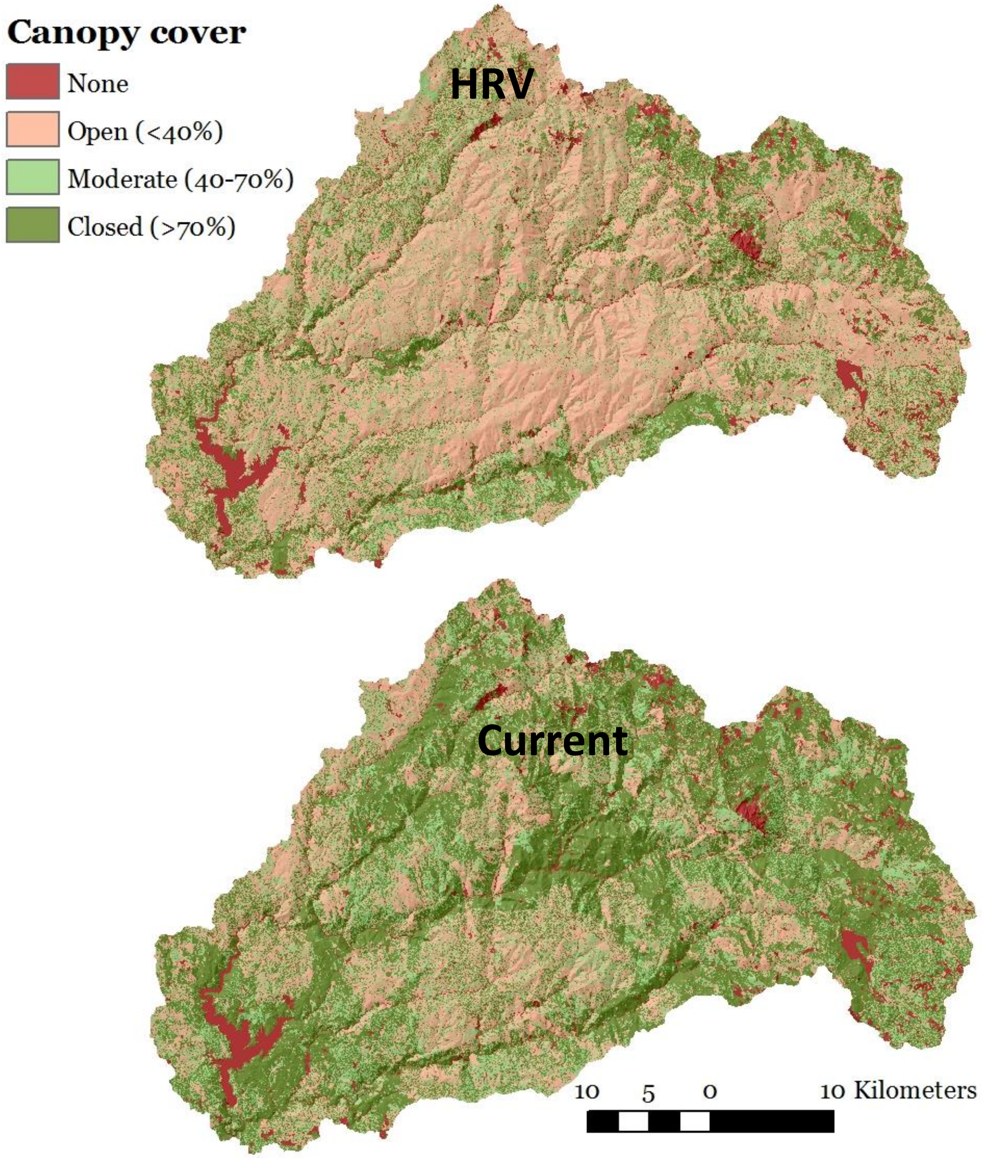
Major Findings

3. The current landscape departs from the historical range of variability in the <u>composition</u> of the vegetation mosaic, and more in some attributes than others.



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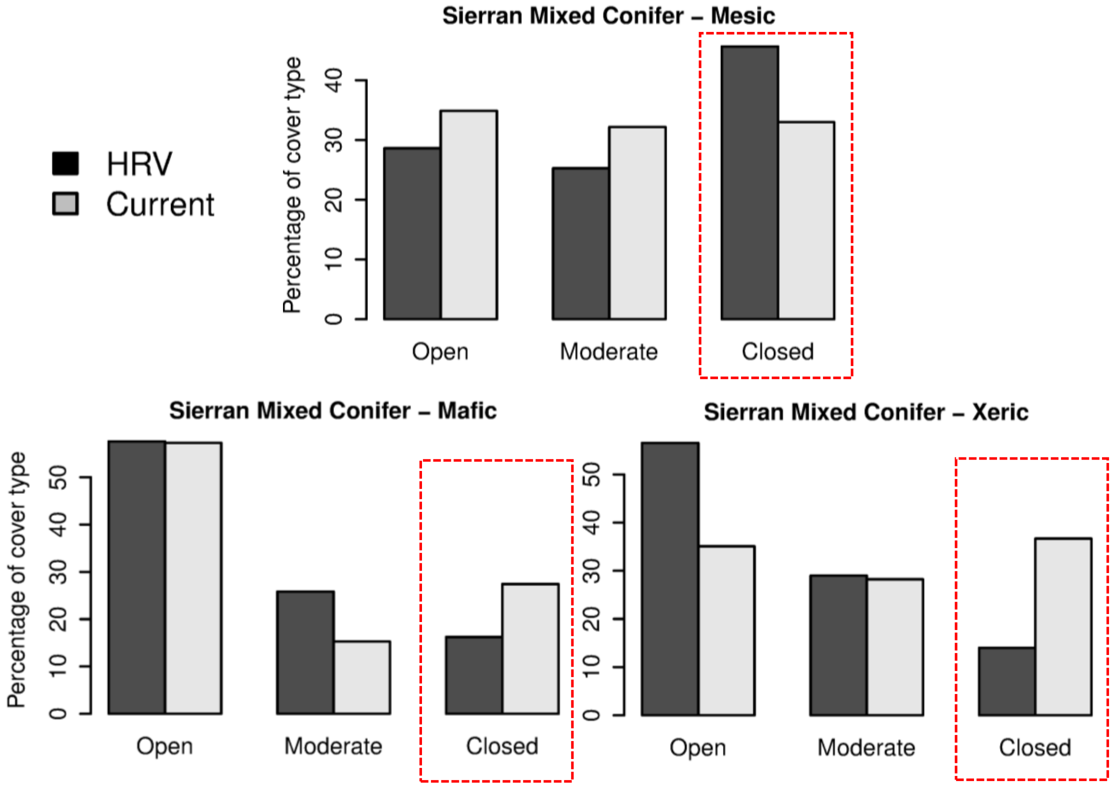

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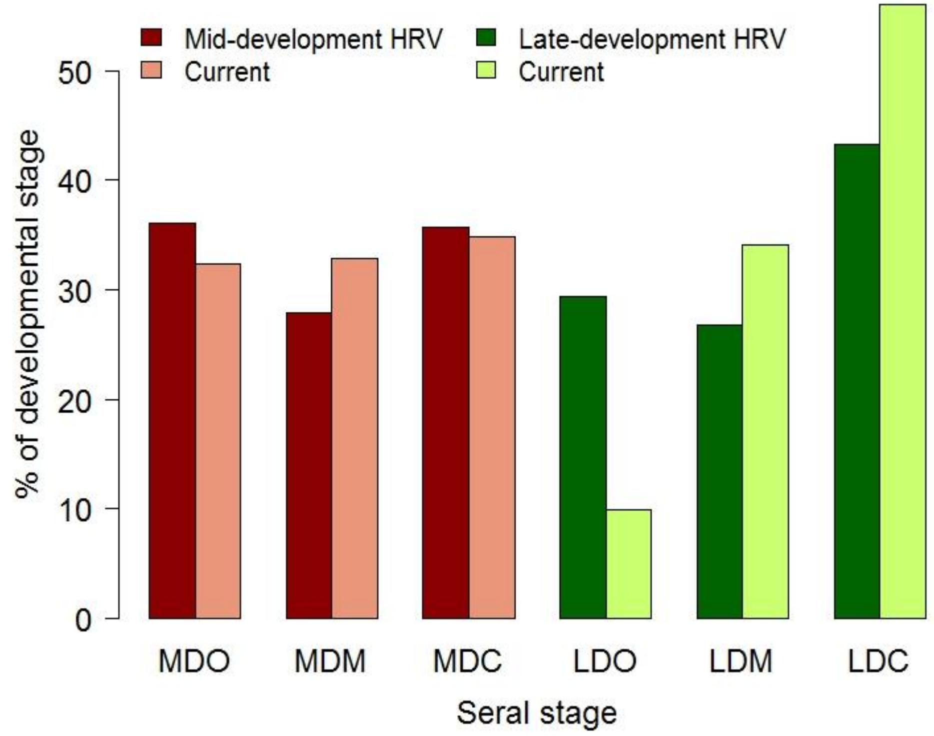
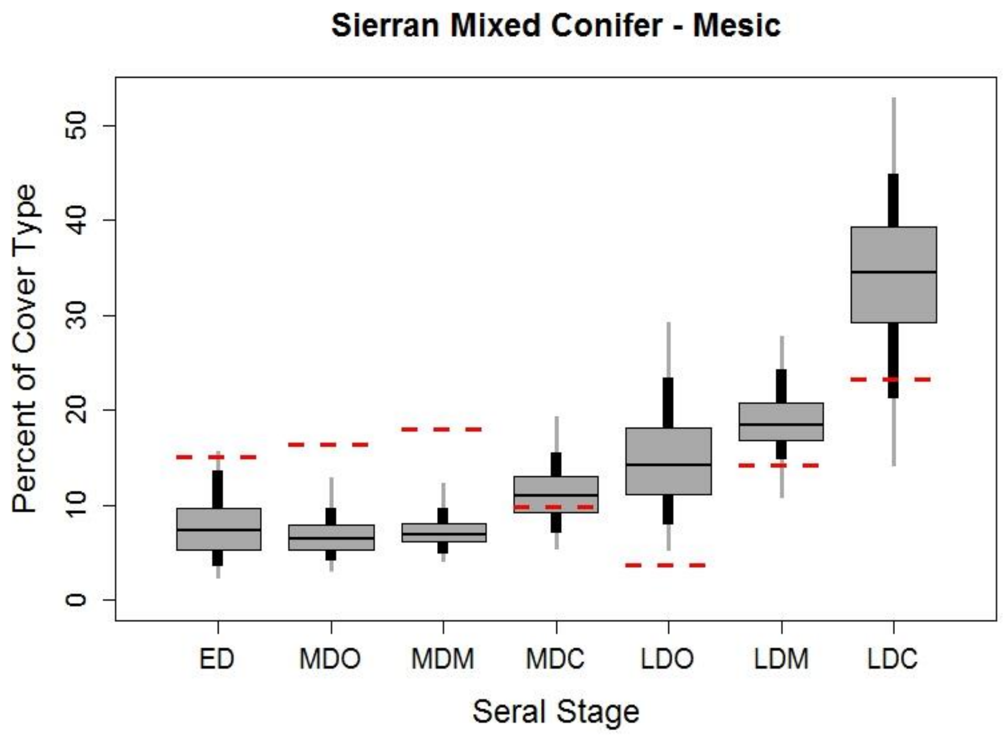


*pooled across cover types

Major Findings

3. The current landscape departs from the historical range of variability in the composition of vegetation mosaic, and more in some attributes than others.

- Judicious application of treatments by cover type
- Account for succession
- SMC-Mesic: focus treatments to maintain open and moderate canopy cover in early- and mid-developmental stages as they succeed to later stages

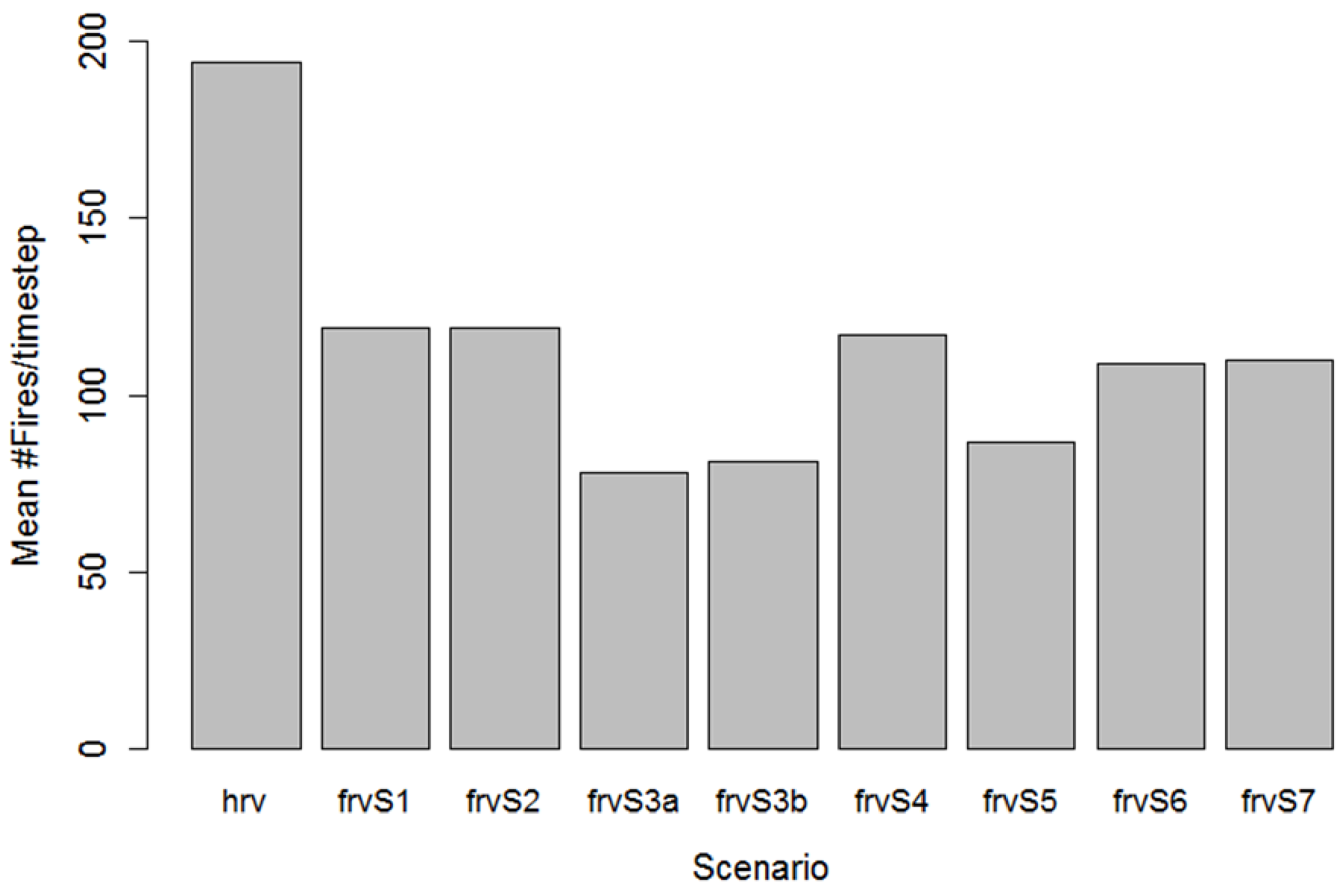


*pooled across cover types

Major Findings

5. Scenario analysis revealed the comparative effects of alternative management strategies on landscape composition and configuration.

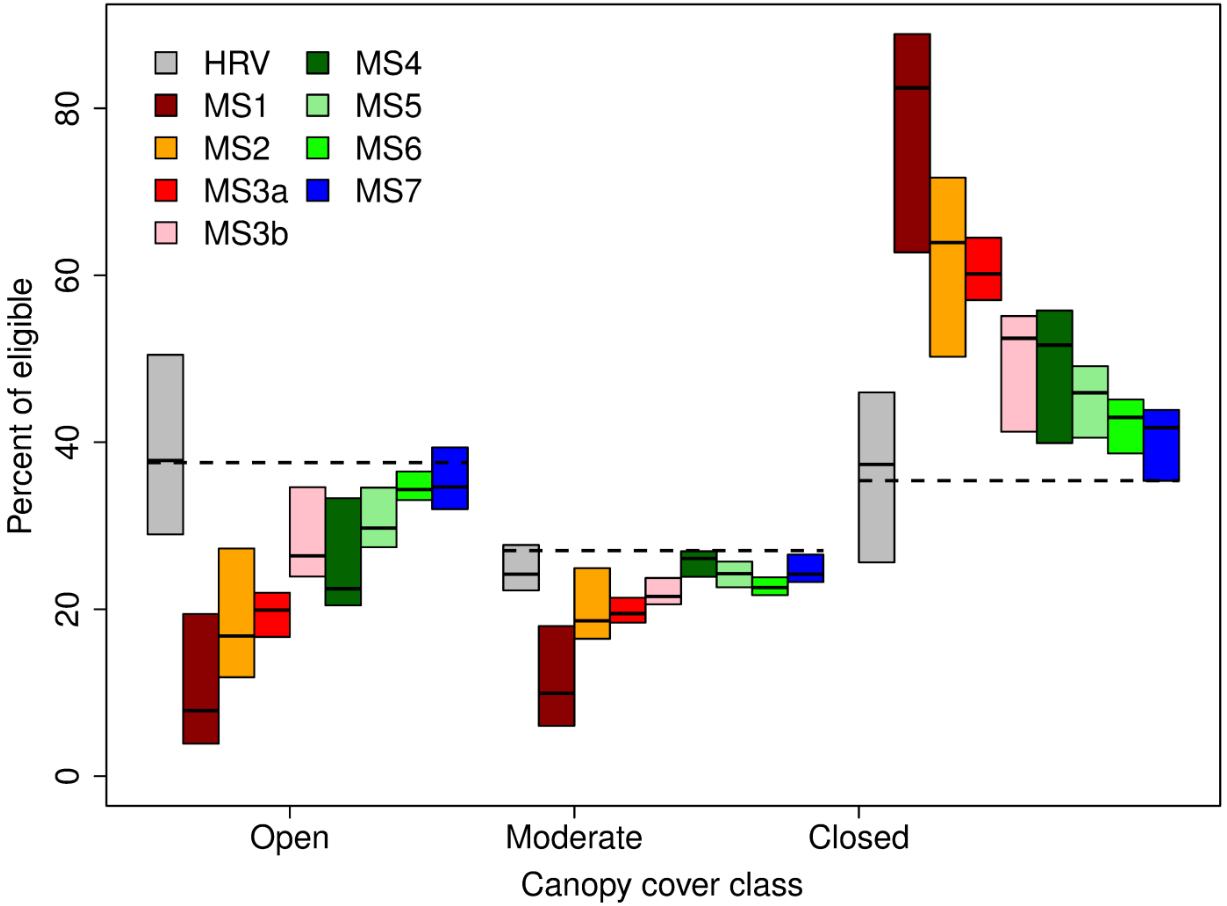
Mean number of wildfires per 5-year timestep for the simulated historical range of variability (circa 1550-1850)(hrv; mean is across 460 timesteps) and future range of variability scenarios with a modified fire regime (*frvS1*) and varying intensities and types of vegetation treatments (*frvS2-7*) (mean is across 20 replicate 100-year simulations; N=200) in the Upper Yuba River watershed.



Major Findings

5. Scenario analysis revealed the comparative effects of alternative management strategies on landscape composition and configuration.

- Management scenarios varied considerably in how well they emulated the HRV in landscape <u>composition</u>
- MS1 (no treatment) and MS2 (current LMP) performing worse, and MS7 doing quite well



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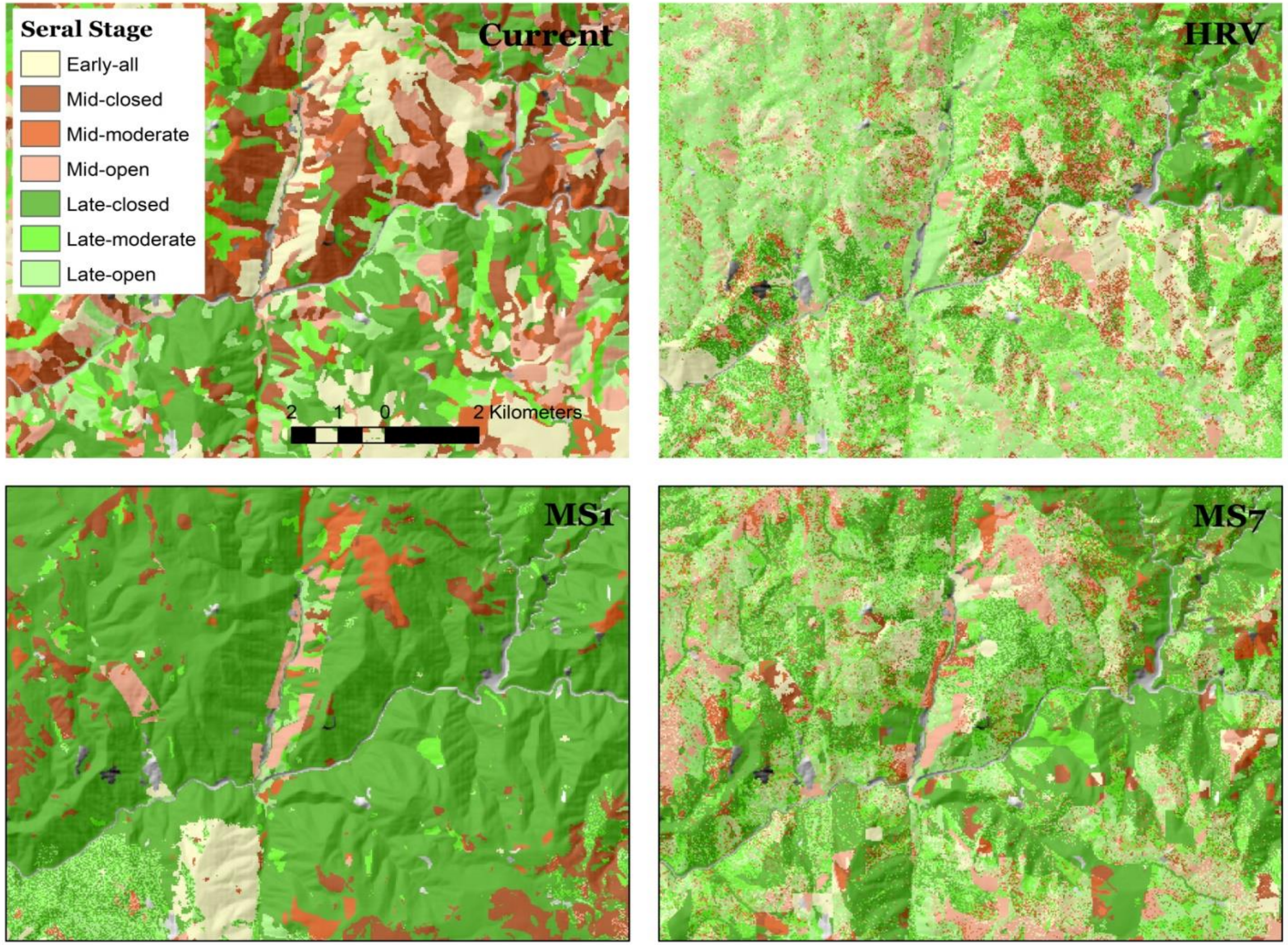
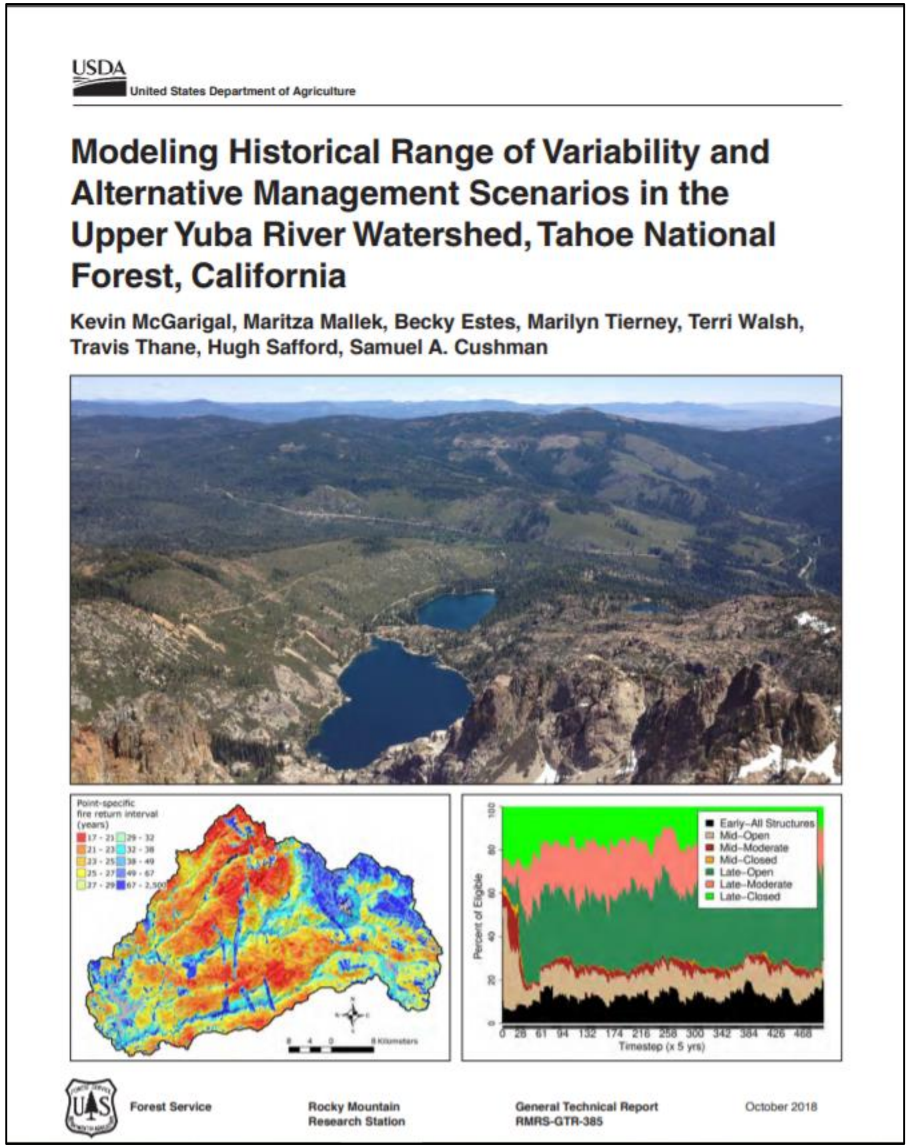


Next Steps

1. Compile input spatial data layers for the LDSM from Tahoe NF Ecobjects database (LiDAR) and other sources as necessary.
2. Re-calibrate the LDSM model based on the revised spatial database.
3. Conduct simulations to quantify HRV and current departure.
4. Develop desired conditions for landscape structure.
5. Collaborate with Region 5 and Tahoe NF staff to establish a framework for the restoration and monitoring plan; i.e. determine the components of the plan and the manner of presentation.
6. Develop and document detailed restoration plan based on the existing HRV and current departure results according to the framework established above.
7. Document the model application, detailed restoration plans and monitoring plan.

Thank You!



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