SUMMARY

JOINT STAKEHOLDER SCIENCE COMMITTEE AND STAKEHOLDER COMMUNITY COMMITTEE MEETING

LAKE TAHOE WEST RESTORATION PARTNERSHIP

Tuesday, May 7th, 2019, 1:00pm to 4:30pm

Tahoe Regional Planning Agency, Sierra Room, Avenue, 128 Market St, Stateline, NV 89410

All meeting materials are publicly available on the Lake Tahoe West website http://nationalforests.org/laketahoewest. For questions please contact the program manager/facilitator Sarah Di Vittorio at sdivittorio@nationalforests.org or (530) 902-8281.

Meeting Synopsis

On May 7, 2019, the Lake Tahoe West (LTW) Stakeholder Science Committee met with the Interagency Design Team (IADT) to view and discuss the integrated suite of Lake Tahoe West modeling results and how they inform the Landscape Restoration Strategy. The IADT also shared the final Decision Model weightings for the Ecosystem Management Decision Support (EMDS) system. The Lake Tahoe West partners are using this tool to interpret and explore thousands of data points from modeling of potential management approaches on the west shore. This tool, including the numeric weightings in the diagram, supports decision making and understanding of complex data, and is not a substitute for the decision-making process. The group approved the hierarchical structure of the EMDS presented today, and the EMDS will move forward as a tool. The IADT also provided an update on project timelines and goals of the upcoming meetings throughout the summer.

Contents

Opening Remarks

- Funding updates.

    - The Lake Tahoe West project will receive $2.9 million for project planning as part of the Southern Nevada Public Lands Management Act (SNPLMA) program, Round 17 funding package.
- Stakeholder meeting schedule through 2019.
    - Stakeholders and IADT will meet once a month except for the month of July. [*Note: we added a workshop for the Stakeholder Community Committee on July 10*.]
        - These meetings will be primarily focused on the Landscape Restoration Strategy.
        - Project planning for Lake Tahoe West will start in October. The teams are currently sketching out what the project planning process will look like.
- The IADT is still awaiting results for EMDS.
    - The IADT will have more information in the coming month or two, and the EMDS will be revisited at the Stakeholder meeting on August 6th.
- Framing for the Lake Tahoe West modeling results.
    - The use of extensive scientific modeling is one of the unique aspects of LTW. The IADT is integrating the Landscape Restoration Strategy with this place-specific modeling effort which focuses on the Lake Tahoe West project area.
    - Typically land managers have to rely on data that is focused on present landscape conditions, but the LTW science effort allows land managers to look over the whole landscape and use results that have projected conditions 100 years into the future.
    - The LTW modeling results are also unique because they show the outcomes of four different treatment scenarios projected 100 years into the future.
    - The IADT is working with the Executive Team to determine how to package the results that are basin-wide. These results may be able to inform management outside of the LTW landscape and allow LTW investments to be leveraged most effectively.

Presentation: Lake Tahoe West Modeling Results

Jonathan Long provided an overview of all of the modeling results. Additional Science Team members including Angela White helped to explain some of the findings.

- The Lake Tahoe West modeling uses interconnected landscape models.
- The LANDIS-II forest landscape model simulates future forests at decadal to multi-century time scales and takes into account disturbances (e.g. fire, insects). Climate and climate change also affect processes throughout the model.
    - LANDIS-II results are then fed into other models:
        - BlueSky - Smoke emissions.
        - BenMAP – Economics.
        - Wildlife - Multi-species biodiversity, three old forest predators.
        - Water quality – FSWEPP.
        - Water quantity – SnowPALM.
- Representation of management scenarios.
    - Scenario 1: Suppression only.
    - Scenario 2: Wildland-Urban Interface thinning.
    - Scenario 3: Landscape thinning (increased extent and intensity).
    - Scenario 4: Prescribed fire * with limited landscape thinning.
        - * Note on Scenario 4: IADT had goal of burning 3200 acres in LTW, but the model was programmed inadvertently to get about 800 acres/year.
            - Science Team is currently working with LANDIS team to scale up burning to get closer to target of 3200 acres/year.

            - There are technical challenges associated with getting the prescribed fire burning up from 800 acres/year to 3200 acres/year.
            - We will share updated Scenario 4 results in the near future.
- LANDIS-II uses a moderate level of climate change projection (RCP 4.5).
    - Using more dire projections (RCP 6.0 or 8.5) would reduce forest growth in later decades but not generally affect relative performance of scenarios.
- Cumulative fire (in ha) for LTW results:
    - Total amount of fire is greatest in Scenario 4 (due to addition of prescribed fire on landscape).
- Treatments alter fire severity results:
    - Cumulative low and medium severity fire (in ha) for LTW has Scenario 4 with the largest area (due to prescribed fire being modeled as low severity wildfire) and Scenarios 1, 2, and 3 performing generally the same.
    - Cumulative high severity fire (in ha) for LTW has Scenario 1 with the largest area (~6000ha) and Scenario 3 with the least amount of area (~3000ha).
        - Questions remain as to what the target for area of high severity fire on the landscape is.
- Treatments reduced area of large (>40 acres) high-severity burn patches results:
    - Scenario 1 is highest in cumulative area burned in high severity patches greater than 40 acres (~13000ha) and Scenario 3 is least cumulative area burned (~7000ha).
- Fine scale modeling - forest structure and fire behavior results:
    - Historical forest conditions reduced canopy consumption compared to current dense forests.
    - Thinning moderated fire intensity and decreased canopy consumption.
    - Heavy thinning (removal of trees up to 30" DBH) promotes aspen-dominated areas.
        - Heavy thinning also increased rate of fire spread (through increased wind velocity).
- Stand scale forest monitoring- forest structure and fuels results:
    - Thinning reduced tree density, and that continued 10 years after treatment.
    - Thinning treatments increased amounts of large (>24" DBH) trees.
    - Thinning treatments reduced the amount of dead basal area, while it increased in 3/4 of the control sites.
        - Where dead basal area = standing dead trees.
    - Thinning generally reduced fuels relative to controls for at least ten years.
        - Duff increased significantly even in some treatment units.
        - Coarse (1000-hr) surface fuels increased over time in all control units, but they also increased in some treatment units.
            - These trends suggest a need for follow-up understory prescribed burning after thinning.
- Landscape vegetation and wildlife results:
    - Forest composition change due to warming.
        - Changes are driven by climate change, though management can temper some of the changes.
        - Results suggest opportunities for adaptive management to promote resilience especially in upper montane (red fir) forests as well as aspen stands.
        - Active treatments might also be important in the sense that species composition changes can then be addressed through selective thinning and targeted reforestation.

- Vegetation types: current to 100 years.
    - Not a significant difference between four scenarios because climate is so dominant.
- Seral stage: current to 100 years.
    - Same general trend, more late seral on the landscape no matter what you do.
        - But Scenario three performs best.
- Species richness (measured in terms of high quality reproductive habitat for species): current to 100 years.
    - Scenario 3 performs best.
- Old forest predator modeling key points:
    - Recruitment of old forest across the basin appears to be a bigger factor than the differences in the scenarios for all 3 old forest associated predators.
    - While territories increase under all scenarios, Scenario 3 yielded slightly more territories for martens and somewhat fewer for owls.
        - More of a penalty under Scenario 3 because of loss of biomass.
    - Attention will be needed to develop mechanical thinning approaches in lower elevation forests capable of maintaining or improving conditions for spotted owls and to monitor their effects.

- Water quantity results:
    - Thinning of understory trees increases water yield (snowmelt volume).
        - Within different areas you will see the most benefit in terms of snowmelt volume from thinning moderately tall, very dense forest stands.
        - Effects do vary across the landscape, with a stronger response at lower elevations.
        - The science team is developing a decision support tool to evaluate expected responses across Blackwood, Ward, General, and Meeks watersheds.
- Water quality - WEPP modeling results:
    - The team took LANDIS outputs for where thinning and burning was occurring and used WEPP to calculate average hillslope yields (sediment, phosphorous) per unit area given current condition, thinning, or fires at different severity.
    - Expected load increases due to fires are much larger (5-300X) than increases from thinning.
        - Loads might be overestimated because model assumes that all of the loads that come off the slope make their way to the channel, but that would likely not happen.
        - WEPP is tied to residual ground cover.
            - Thinning would leave some residual ground cover.
            - Models prescribed burns as low severity fire.
            - Fire location is really important because of slope and sensitive soil types that produce more loads.
    - Differences in loads by scenario are dominated by changes in Blackwood and Ward watersheds.
        - If a fire happens in these areas, it will produce dramatic sediment load results.
        - Results are sensitive to stochastic, extreme events in highly erodible areas.
            - A wildfire in Blackwood Canyon in Scenario 4 in model year 30 results in high loads.
- Loads resulting from treatments are much lower (order of magnitude lower) than background loads from natural erosional processes.

- Water quality – WEPP road modeling results:
    - Forest roads and water quality.
        - Generally, the forest road system in Tahoe is well maintained, so risks to water quality appear comparatively low in most segments.
        - Some segments do pose higher risk due to steep slopes and erodible soils.
            - Opportunities to treat these roads to reduce sediment delivery.
        - Roads have elevated sediment delivery during active use.
            - However, these conditions are very short term. After finishing treatment, the road will likely return to low risk.
        - Roads and water quality implications.
            - Effects of reopening legacy roads, creating new temporary or long-term roads, and closing or removing old roads are highly dependent on specific landscape contexts.
            - Due to this modeling effort the tools are now available if a manager needs to evaluate where to put roads on the landscape.
        - Question: What kind of treatment are you doing to reduce risk?
            - Roads re-armor themselves with precipitation and snow.
        - Question: Would you also see this same recovery in burned areas?
            - Modeling: If you don't have storm coming in after prescribed fire, the loads will drop.
            - A manager could time their prescribed fire to take into account weather patterns.
                - This is one reason why the Science Team wants to highlight that modeling prescribed fires as low severity wildfires may not be correct.
- Air quality results:
    - Health impacts are very uncertain due to variable weather and resulting population exposure.
    - Daily emissions are therefore a useful proxy indicator for health impacts.
    - Modeling strategy: LANDIS-II -> BlueSky -> BenMAP.
    - Key findings from emissions:
        - Modeled treatments reduce fuel consumption, leading to lower overall emissions and fewer days of high emissions, but there is much variation in individual smoke events and resulting impacts.
        - Prescribed burning results in moderate emissions, which could have measureable impacts even if they remain within regulatory limits due to their frequency.
        - However, managers may also be able to time and manage such burns to minimize impacts in ways that broad-scale modeling can’t capture well.
    - Total particulate emissions by Scenario.
        - Scenario 3 performs best in terms of overall emission reductions.
        - Scenario 1 is worst.
        - Scenario 4 is higher than Scenario 2.
- Economic results:
    - Economic estimates of smoke impacts.
        - Evaluated based upon willingness to pay to avoid health impacts from smoke.
        - Weather conditions can cause large changes in magnitude of impact.

        - High levels of daily smoke emissions reach very large populations in Reno and/or the Central Valley.
        - Emissions and economic impacts from individual extreme wildfires vary widely across and within scenarios.
            - Highest: Scenario 1 (~$10M-$77M).
            - Lowest: Scenario 3 (~$2M-$18M).
    - Carbon sequestration increases over time in all scenarios, and is dominated by in-forest carbon storage.
        - Most carbon sequestration: Scenario 1.
        - Least: Scenario 3.
        - Treatments slow the pace of carbon storage despite avoiding emissions from wildfires.
        - Scenario 3 does stores the least carbon because of loss of trees, not enough significant fire in this landscape to compensate for loss of trees.
    - Average annual costs of treatment and suppression (2010 – 2040).
        - Scenario 1: $1.7M.
        - Scenario 2: $3.2M.
        - Scenario 3: $5.4M.
        - Scenario 4: $2.7-6M.
    - Property at risk in LTW (2010-2040).
        - Scenario 1: $607,705,000.
        - Scenario 2: $648,930,000.
        - Scenario 3: $264,810,000.
        - Scenario 4: $130,465,000.
- Overall Evaluation:
    - Treatment promotes most objectives.
        - Modeling suggests that more treatment favors most resource values, except carbon sequestration and cost of treatment.
        - Scenario 1 and 2 do not lower key risks from high-severity wildfires (property loss, large patches, and extreme emission days) as effectively as Scenario 3.
    - Large old forest increases.
        - The values associated with old-forest are generally sustained and even enhanced with treatment.
    - Expect more fire regardless of scenario, but expect less severe fire w/ treatment.
    - In general, thinning is important and low-risk.
    - Prescribed burning is important, although it may entail more risk.
        - Model results may overestimate some risks (especially water quality) from landscape prescribed burning.
        - Further analysis needed for how extensive frequent prescribed burning would affect water quality and quantity.
- Next steps:
    - Create a preferred scenario to help evaluate the restoration strategy compared to a reference.
    - Refinement of results for air quality and water quality.
    - Reporting and publication of findings.

- Clarifying questions:
    - The results show red fir and chaparral decline; how much will that actually play out?

        - Some of this has to do with how the models classified species into Sierra mixed conifer. If you get red fir and white pine in the same spot that be classified as mixed conifer. Thus it is not surprising that mixed conifer is winning out.
        - Given that we didn't see a lot of fire on the landscape the decrease in chaparral is not surprising.

Key Points for the Landscape Restoration Strategy

Brian Garrett described how the IADT is using the modeling results to inform the LRS.

- The LRS is informed by:
    - Most current and available science.
    - Professional expertise of multiagency team of resource managers.
    - LTW-specific science modeling.
- Incorporation of modeling results.
    - IADT is using the modeling results to understand the impacts of treatments on resource values over time.
    - The modeling is also useful in that it validates that management actions in LRS will result in positive outcomes over time and there is support for whole landscape approaches (expanding treatments across WUI).
- Areas of uncertainty and elevated risk of impact.
    - In terms of water quality, the LRS will recommend managers design treatments that take special care on the most sensitive soils.
    - The increased use of roads for removal of restoration byproducts has short term risks for water quality. Again the LRS will note ways to minimize risks and managers will use best management practices.
    - The increased use of prescribed fire may increase risk to air and water quality.
- Beneficial treatment elements.
    - Prescribed fire is an important post thinning treatment for managing the accumulation of surface litter and surface fuels.
        - The LRS recommends increase use of prescribed fire after thinning.
- Economics of treatments.
    - The LRS recommends using lower cost treatments such as prescribed fire in areas of the landscape that do not need thinning as an initial treatments and in areas where resources may be sensitive to mechanical thinning treatments.
- Incorporating adaptive management. The LRS will highlight several areas for adaptive management including to:
    - Evaluate the benefits and risks of taking understory burning to larger scales.
    - Evaluate potential risks of treatments in sensitive areas suggested by modeling.
    - Use monitoring and adaptive management to evaluate model predictions for key indicators and management performance .

Discussion of Modeling Findings

- Responses from Stakeholders:
    - Questions from Stakeholders:
        - The Scenario 4 discrepancy of 800 acres/yr vs. 3200 acres/year: how has that affected results? What will the team be doing to address that and how much of an impact it could have?

        - Sediment loading for post-fire vs. roads. It was shown in models that roads could recover quickly, could this potentially be the same for post-fire? Could you tell me more about the modeling process behind this?
        - I found the significant impact of fire on water quality and the greater benefits of thinning vs. fire for water quality to be surprising.
        - What post-prescribed-fire treatments could be done to mitigate this?
        - I would like to dive more into water quality results and how opening forest roads could impact this metric.
        - I am also interested in how we are dealing with the social components of expanded treatment on the landscape. No one wants to see logging and no one wants to see fire in their backyard.
            - What are we doing about the social constraints associated with this project?
        - I am surprised by no differences/marginal differences in species richness, vegetation types, and the seral stage in the four different treatment scenarios
        - Scenario 3 has about twice the acres treated for not that much more benefit.
- Responses from IADT members:
    - What we've seen from California wildfires in the past several is unprecedented, despite this extreme level of fire not being seen in the model it's important to keep this in mind.
    - Our vegetation is resilient, but our communities are not as resilient as our forests.
    - All of the modeling is showing we're going to have increased fire…more smoke, more risk. It would be helpful for stakeholders to help us think about barriers to using fire and what are the best approaches for us to be more successful in using this tool?
    - More area burned no matter what, but severity fire of fire is lowest when we treat most of landscape.
    - Themes:
        - IADT knew from beginning that some of the biggest challenges would be potential impacts of treatment on water quality. LRS needs to be in line with that finding.
        - Concerns about how to balance social acceptability with the level of treatment needed on landscape.
- Responses to Stakeholder's questions
    - Scenario 4, would it be different if we ramped up?
        - When we re-run Scenario 4 it will likely look like Scenario 3 because effects are structural.
    - Mitigate for erosion effects after prescribed fire?
        - It would be useful in the LRS to have a section such as, "if you're going to do prescribed fire, these are areas where special caution is needed."
        - LANDIS-II was modeling prescribed fire as low severity wildfire and a manager would likely have a more sophisticated technique when it comes to managing prescribed fire.
        - In example, a manager could time prescribed fire treatment around channel restoration.
        - Some of the WEPP folks also pointed out that charcoal can actually help sequester phosphorous in landscape
        - The extremely negative impacts from prescribed burns only occur on specific soil types or slopes.
            - This is an important element to put into strategy.

- The benefits vs. impacts of large treatment area on landscape?
    - For all the extra treatment you're doing under Scenario 3, maybe there's not really extra benefit.
        - The main difference lies in high severity fire between scenarios.
        - The EMDS will help us analyze the trade-offs between scenarios further, because what is marginally different to one person might be reason enough or action to another person.
- Is this discussion supposed to lead to a revised/hybrid strategy?
    - IADT needs revised Scenario 4 results first.
    - Good chance that tracking of scenarios that are going to play out in EMDS will give you good pointers in putting together a hybrid scenario. This may give you some useful insights into putting together hybrid scenario.
    - The IADT and Science Team do intend to run a hybrid scenario; however the timing is uncertain at this point.

Decision Model Weighting

Forest Schafer provided an overview of the final Decision Model weighting for the EMDS (attached), which mostly reflects the discussion and consensus from the March 26 Stakeholder Committees meeting. The only change is that the IADT decided to change the relative weighting between the Community Values and Environmental Quality by 0.5 to make them slightly closer. Keith Reynolds provided additional context regarding how the role of the weighting and of the Decision Model in the EMDS.

- The hierarchy will always include disclaimer language to emphasize that the EMDS is used to support decision making, it is not a substitute for the decision making process.
- Environmental values vs. community values.
    - Originally there was some concern around the difference in numeric rankings between environmental values and community values. It was felt that the much higher weight given to environmental values did not reflect the sentiment that environmental values were only, "slightly more important" than community values.
    - A half step rating helped ameliorate the concerns around this optic.
- **Group consensus was reached to move this Decision Model weighting forward.**

Meeting Attendees

<u>Organizing and Participating Agencies</u>

CTC – California Tahoe Conservancy

FWS – Friends of the West Shore

NFF – National Forest Foundation

SFL - Sierra Forest Legacy

CSP – California State Parks

TFFT – Tahoe Fire and Fuels Team

NTFPD – North Tahoe Fire Protection District

US EPA – United States Environmental Protection Agency

TRPA – Tahoe Regional Planning Agency

USFS LTBMU – U.S. Forest Service Lake Tahoe Basin Management Unit

USFS PSW – U.S. Forest Service Pacific Southwest Research Station

Stakeholder Science and Community Committee Members

1. Eric Horntvedt, NTFPD
2. Jack Landy, US EPA
3. Jennifer Quashnick, FOWS
4. Sue Britting, SFL
5. Matt Freitas, TRWC

Staff

1. Svetlana Yegorova, CSP
2. Jen Greenberg, CTC
3. Christine Aralia, CTC
4. Sarah Di Vittorio, NFF
5. Forest Schafer, TFFT
6. Brian Garrett, USFS LTBMU
7. Christina Restaino, TRPA
8. Jonathan Long, USFS PSW
9. Angela White, USFS PSW
10. Bri Tiffany, NFF
11. Keith Reynolds, USFS PSW

Lake Tahoe West Science Modeling Results Overview

Compiled by Jonathan Long

5/6/2019

based upon results delivered by the LTW Science Team

Special thanks to: Angela White, Charles Maxwell, Sam Evans, Timothy Holland, Stacy Drury, Brandon Collins, Chad Hoffman, Justin Ziegler, Adrian Harpold, Bill Elliot, and Keith Slauson for figures

USDA Forest Service
Research & Development

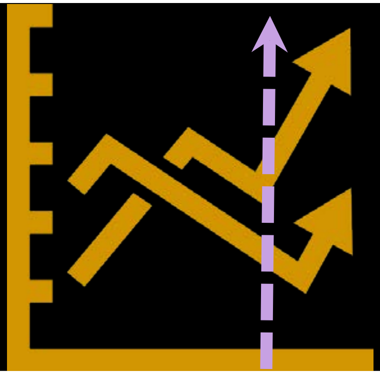
Outline

- Overall structure
- Results for key resource values
  - Disturbance dynamics (landscape-scale and fine-scale)
  - Vegetation
  - Wildlife habitat
  - Water quantity
  - Water quality
  - Emissions and air quality
  - Economics and whole system carbon
- Overall outcomes
- Next steps

Modeling Structure: Dynamic, landscape modeling needed to quantify risks

Scale

Dynamic Over Decades



Future snapshot

Landscape

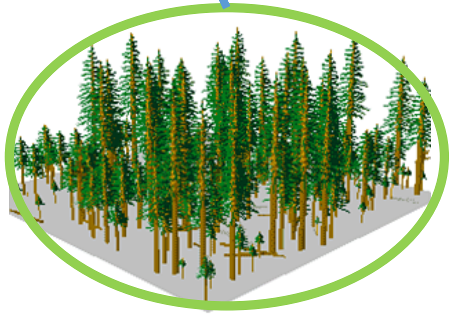
Vegetation
Disturbances
Wildlife Habitat
Emissions

Economics

Water Quality

Smoke Impact

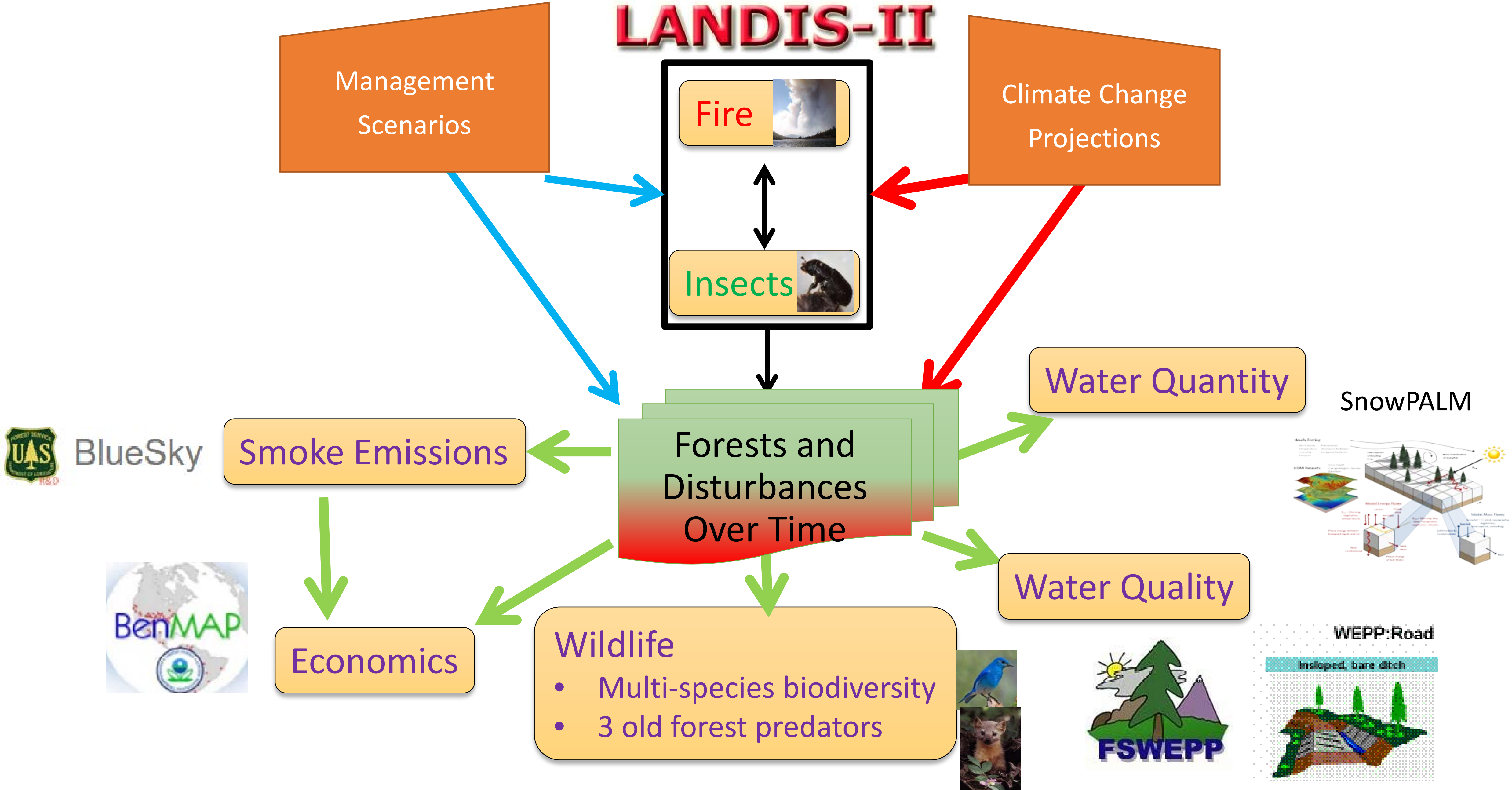
Water Yield



Stand

Fire Behavior

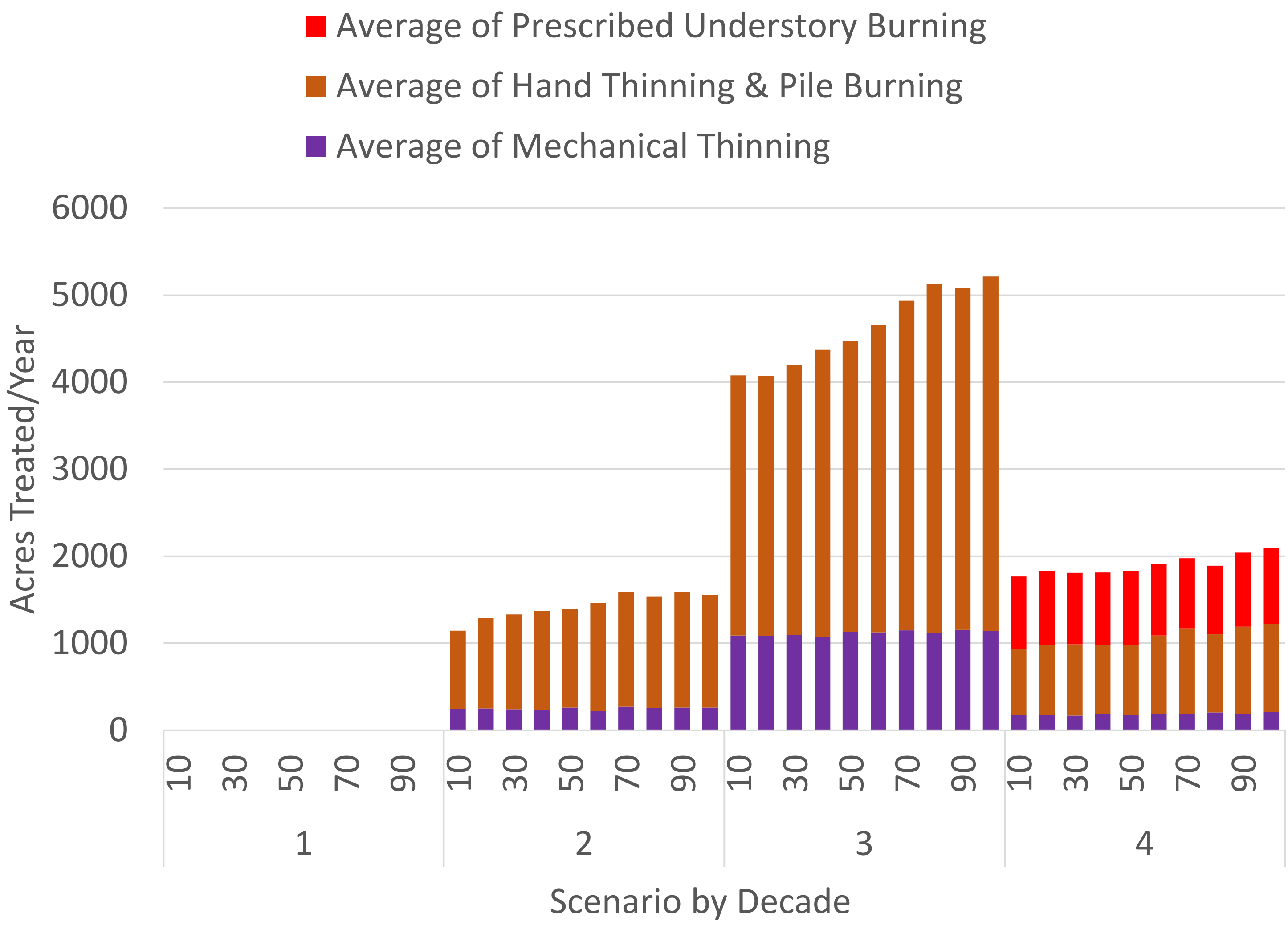
Interconnected Landscape Models



Representation of Management Scenarios

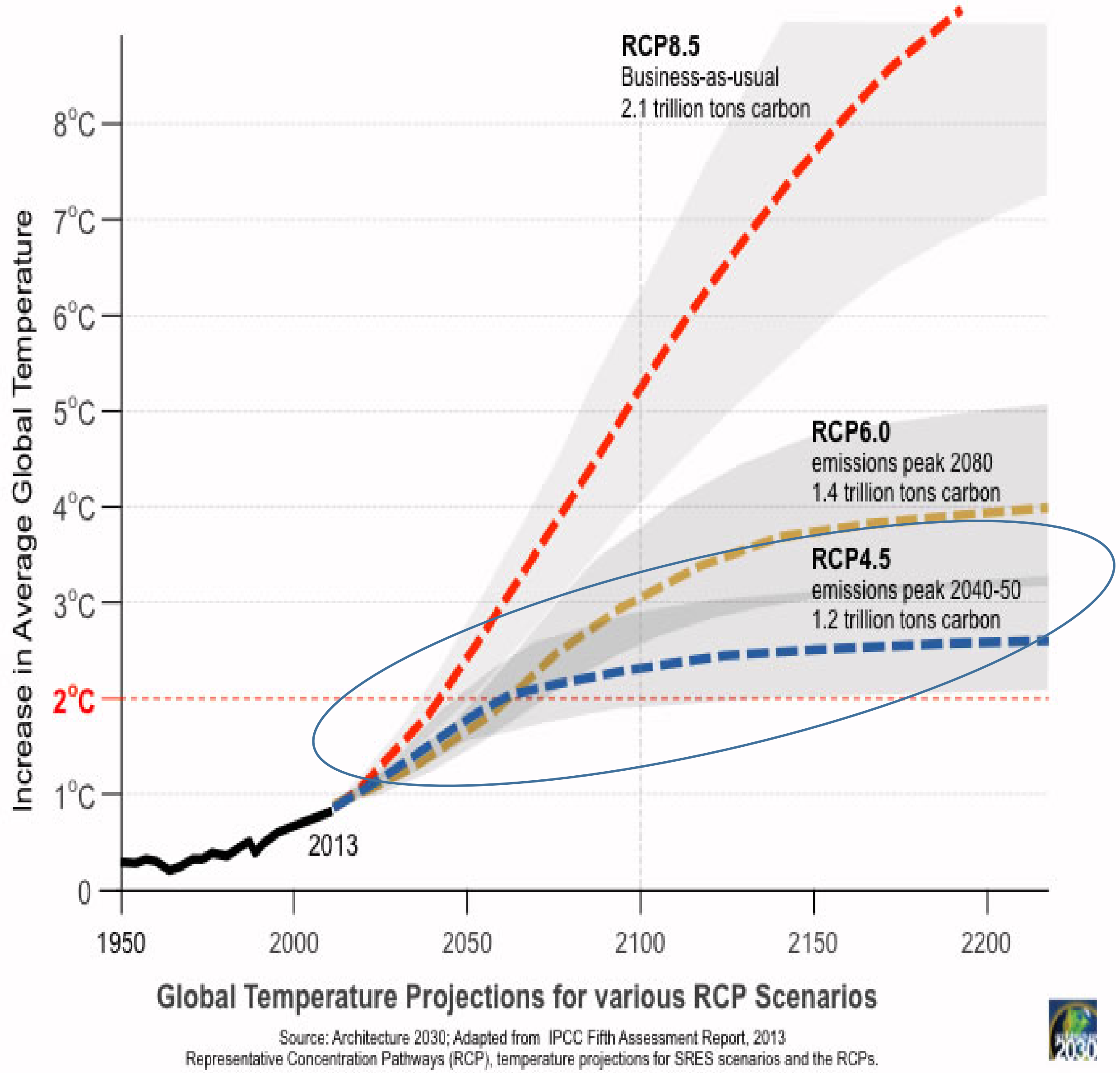
1. Suppression only
2. Wildland-Urban Interface thinning
3. Landscape thinning (increased extent and intensity)
4. Prescribed fire* with limited landscape thinning

*Only ~25% (800 acres/year) of Design Team's intended target for prescribed burning acres in LTW (3200 acres/year)



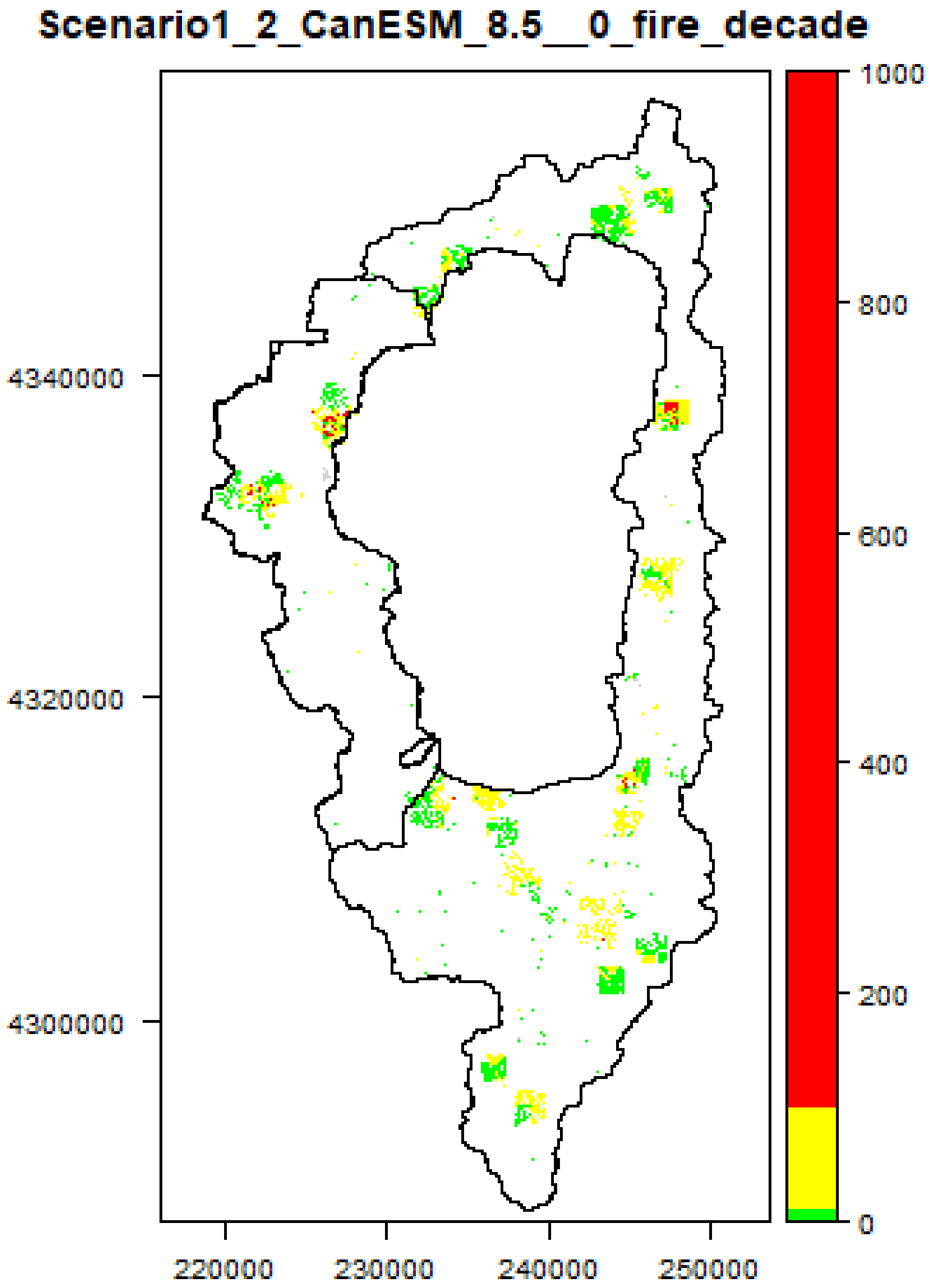
Considering Moderate Levels of Climate Change

- Primary landscape results were based upon RCP 4.5 climate change projections (optimistic but significant warming from historical climate)
  - higher winter minimum temperatures
  - longer growing seasons
- Using more dire projections (RCP 6.0 or 8.5) would reduce forest growth in later decades but not generally affect relative performance of scenarios

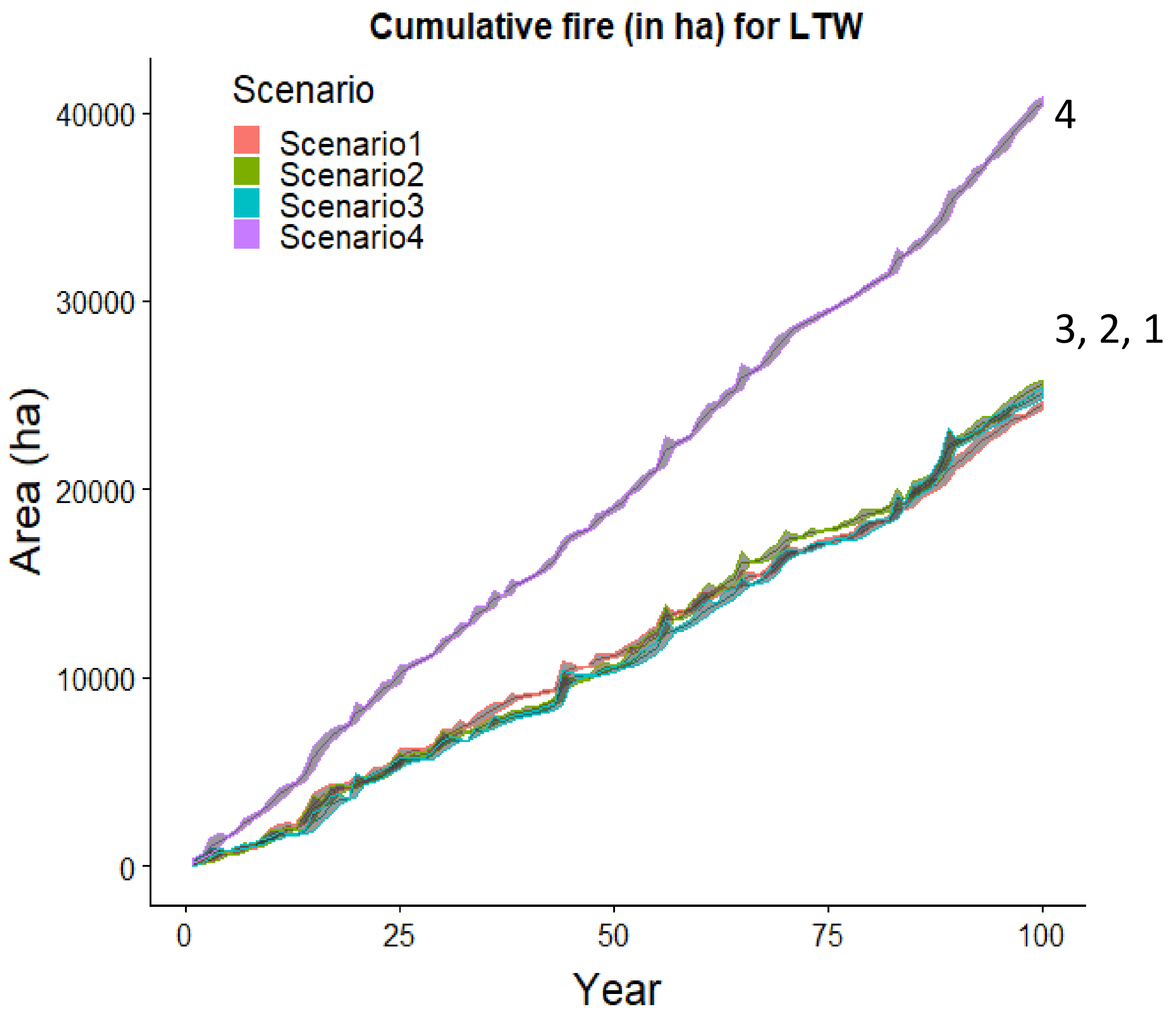


Landscape Outcomes

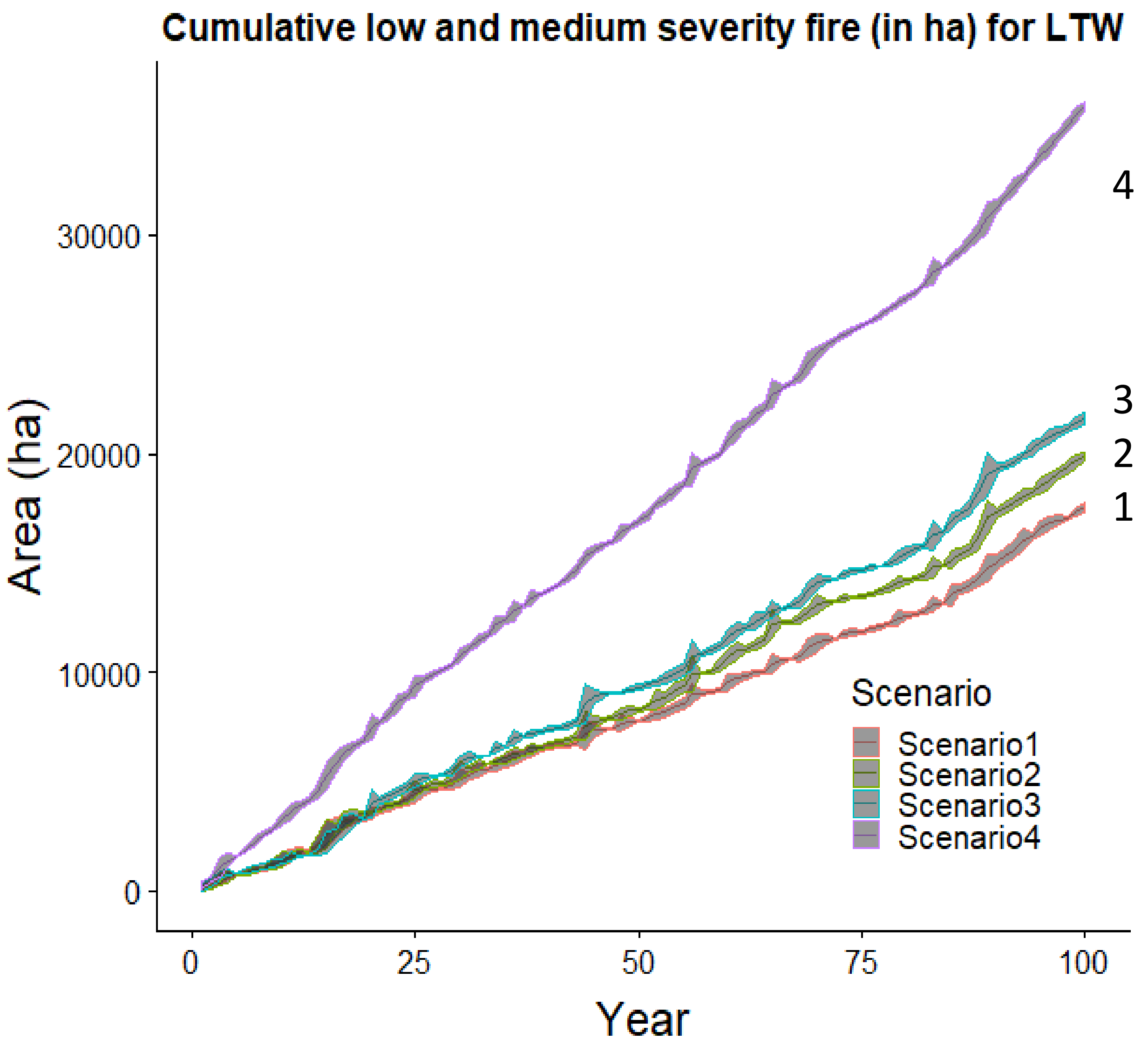
Fires

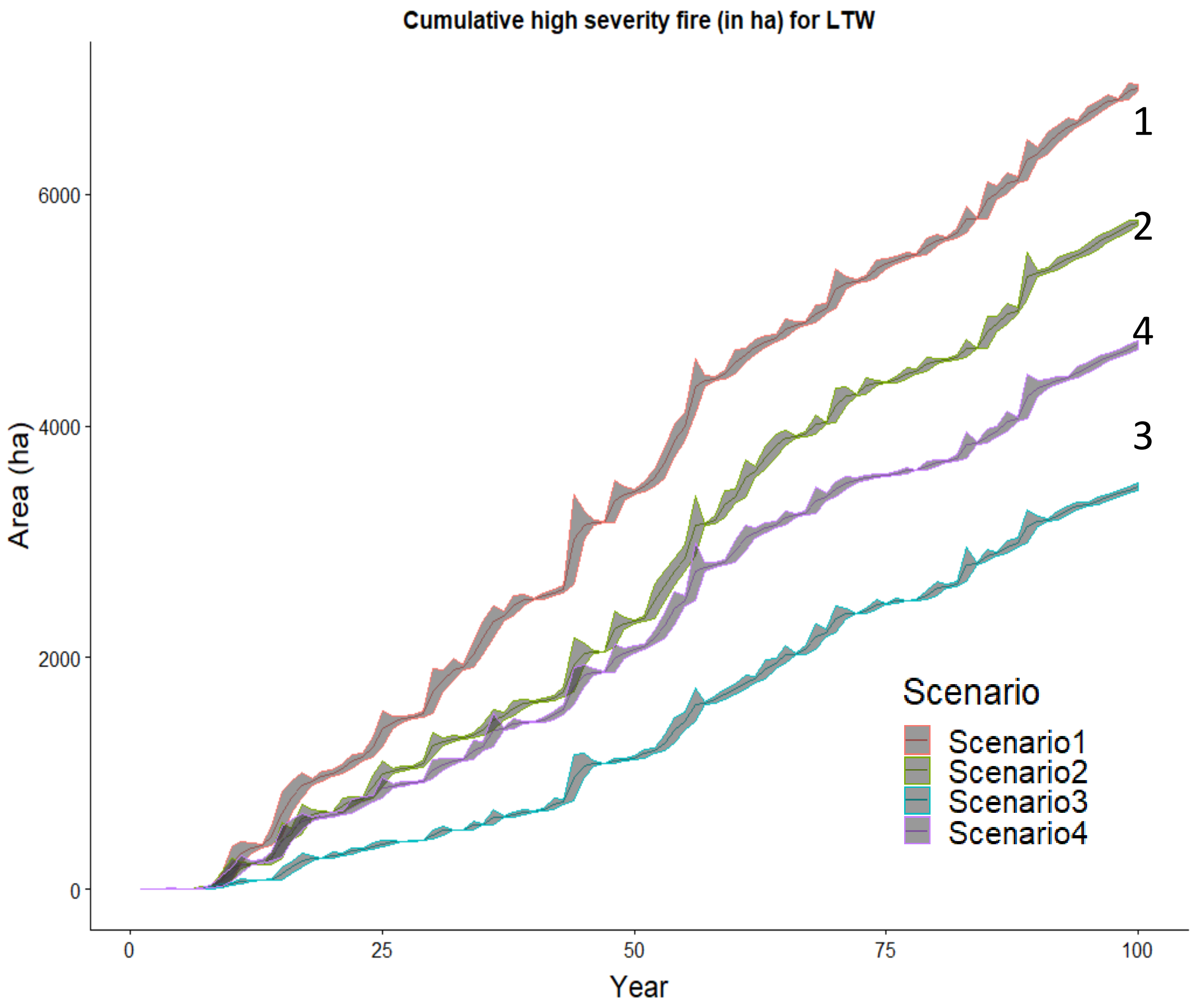


Total Amount of Fire is greatest under Scenario 4 (due to addition of prescribed fire)

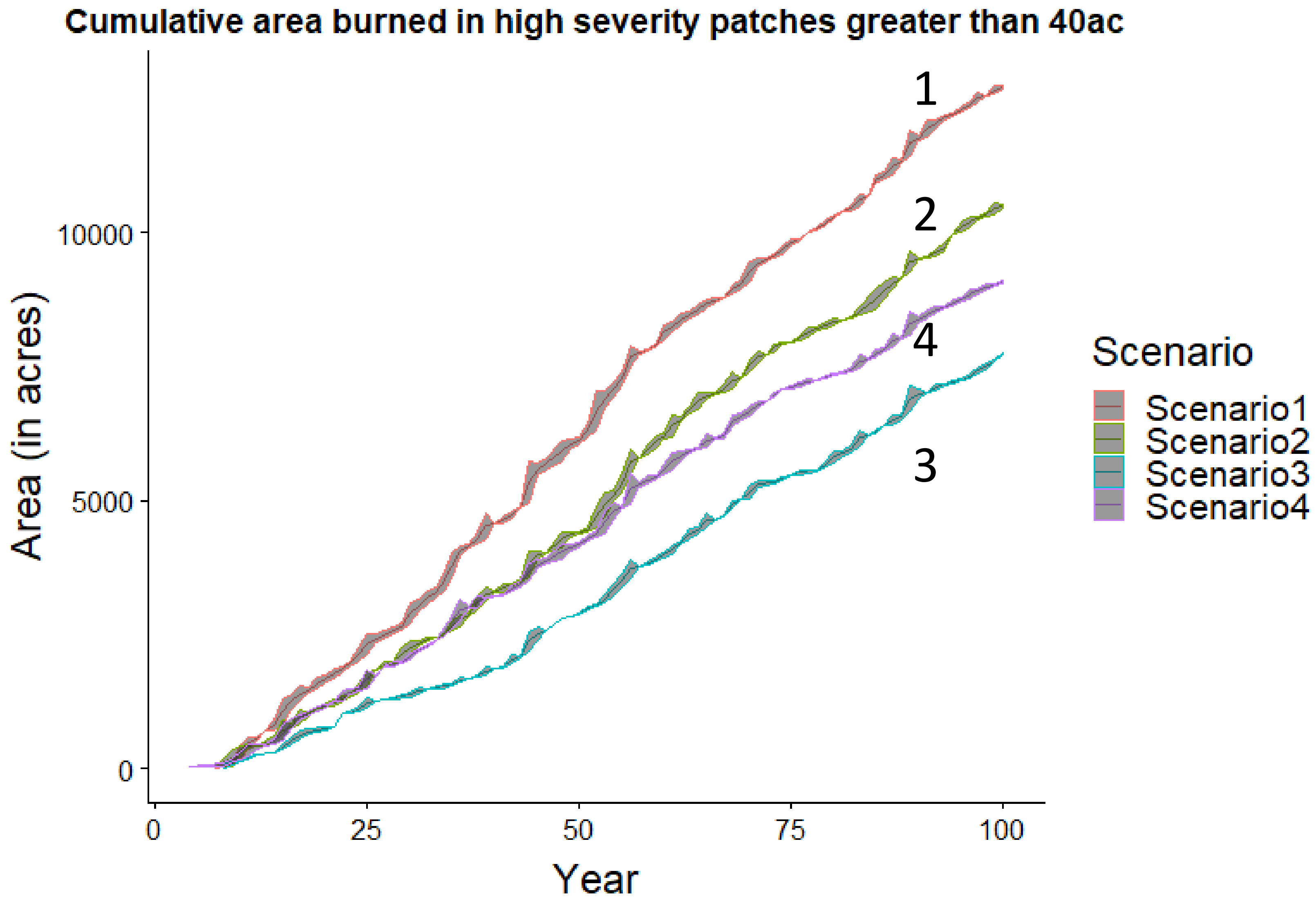


Treatments alter fire severity





Treatments Reduced Area of Large (>40 acre) High-Severity Burn Patches



Fine-scale Modeling Results: Forest Structure Fire Behavior

Applied the Fire Dynamic Simulator to:

Mixed-conifer reference and current stands in the Stanislaus-Tuolumne Experimental Forest

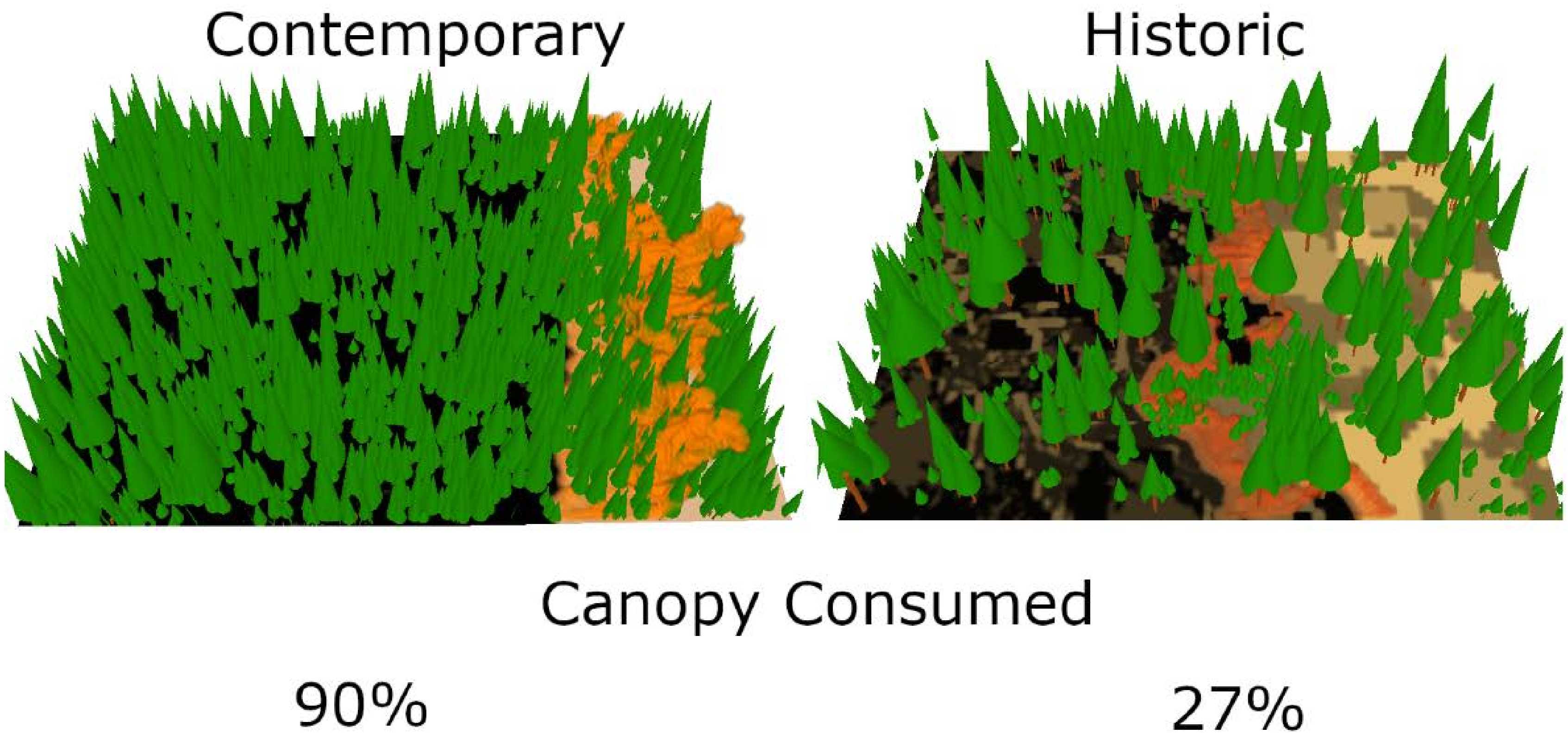
Aspen-conifer stands, untreated and treated in Lake Tahoe using plot data from John-Pascal Berrill

Lead Investigators: Chad Hoffmann and Justin Ziegler, Colorado State

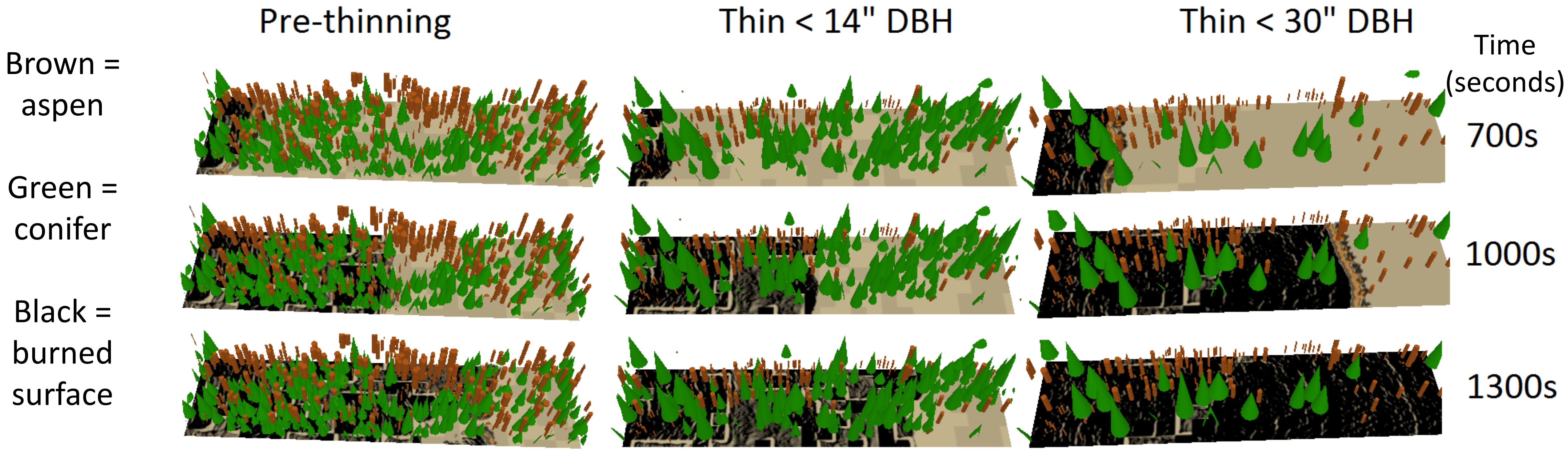
Brandon Collins, UC Berkeley

Historical forest conditions reduced canopy consumption compared to current dense forests

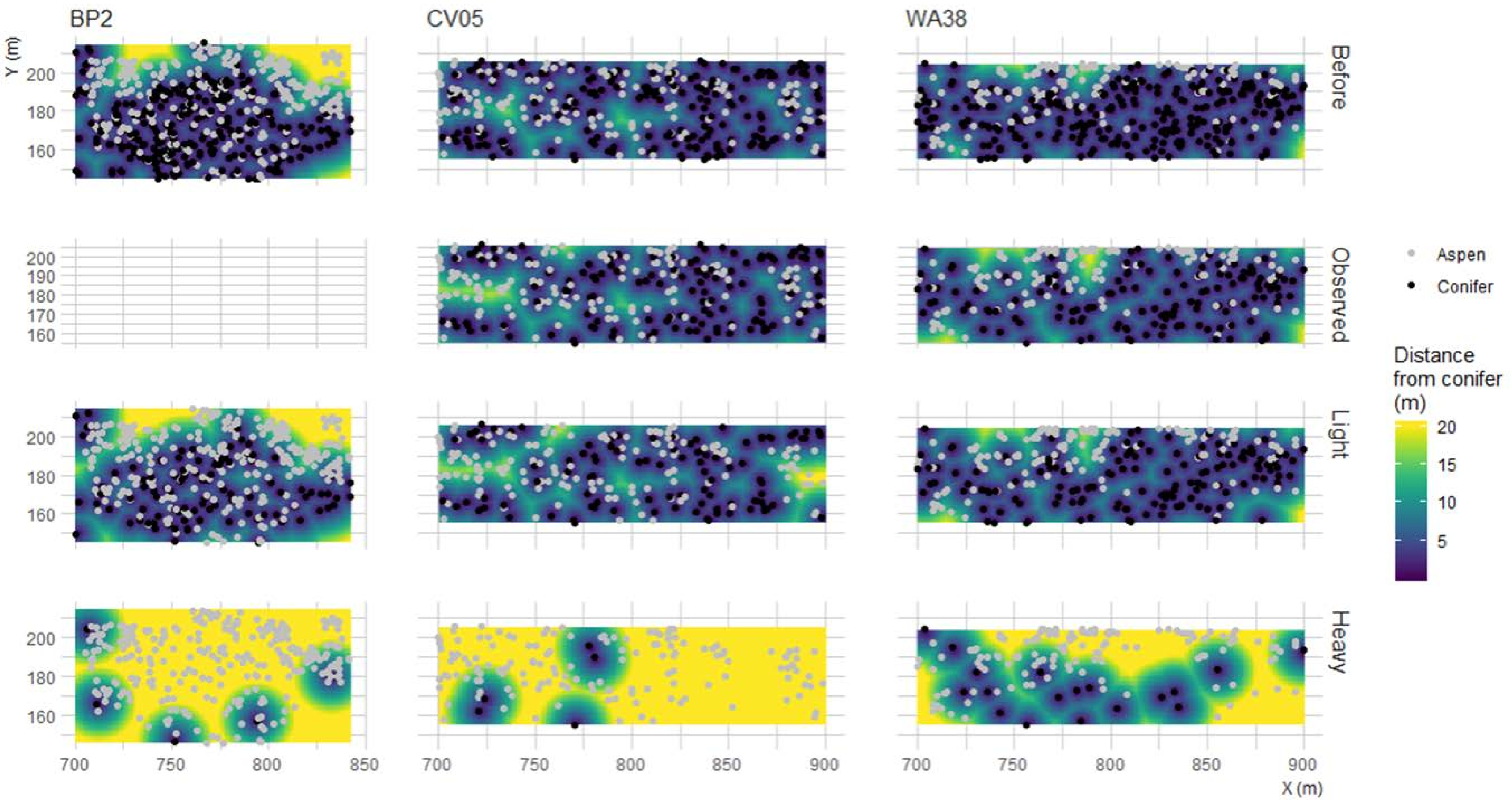
- Due to reduced fuels, especially from smaller trees



Thinning moderated fire intensity and decreased canopy consumption
Heavy thinning also increased rate of spread (through increased wind velocity)



Heavy thinning (removal of trees up to 30” DBH) promotes aspen-dominated areas



Stand-scale Forest Monitoring: Forest Structure and Fuels

Remeasured Upland Fuel Reduction plots in Lake Tahoe West previously established by Manley and White

Lead Investigator: Brandon Collins

Thinning reduced tree density, and that continued 10 years after treatment

Thinning treatments increased amount of large (>24”DBH) Trees

- Large trees also increased (by smaller amounts) in most controls
- Results are consistent with landscape modeling results

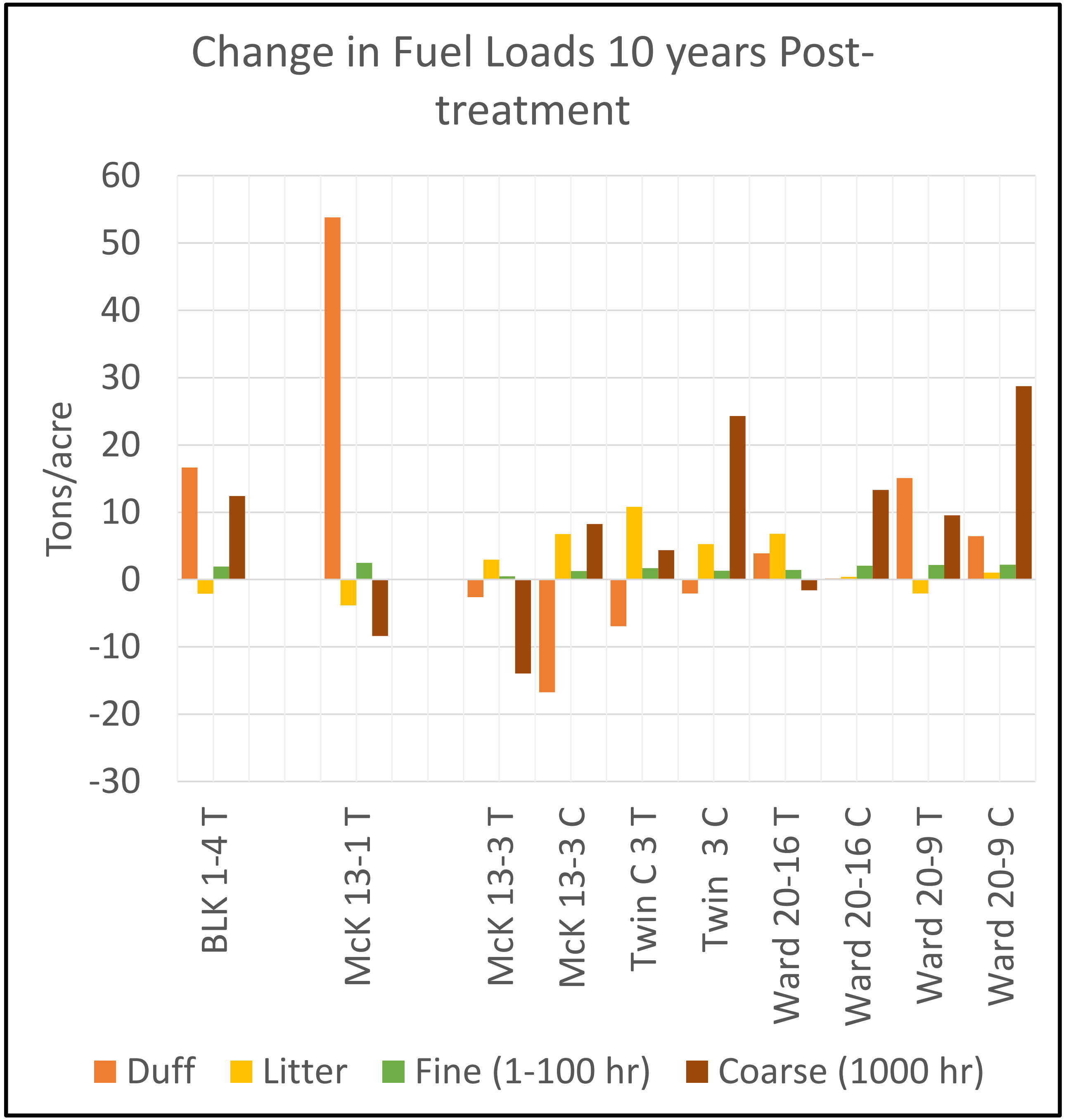
	Tree ac^{-1} (>24" dbh)		
Unit	Pre	Post 10yr	% change
Blackwood 1-4 T	25	31	**25**
McKinney 13-1 T	11	18	**64**
McKinney 13-3 T	7	16	**118**
McKinney 13-3 C	13	24	**86**
Twin Crags 3 T	17	17	0
Twin Crags 3 C	30	27	-9
Ward 20-16 T	19	32	**68**
Ward 20-16 C	14	21	**50**
Ward 20-9 T	14	21	**47**
Ward 20-9 C	21	27	**26**

Thinning treatments reduced the amount of dead basal area, which increased in 3/4 of the control sites

	Dead basal area (ft^2ac^{-1})		
Unit	Pre	Post 10yr	% change
Blackwood 1-4 T	76	38	-50
McKinney 13-1 T	75	55	-27
McKinney 13-3 T	130	12	-91
McKinney 13-3 C	93	111	**19**
Twin Crags 3 T	92	73	-21
Twin Crags 3 C	60	86	**43**
Ward 20-16 T	50	45	-11
Ward 20-16 C	86	65	-24
Ward 20-9 T	61	18	-70
Ward 20-9 C	37	53	**41**

Thinning generally reduced fuels relative to controls for at least 10 years

- Coarse (1000-hr) surface fuels increased over time in all control units, but they also increased in some treatment units.
- Duff increased a lot even in some treatment units.
- These trends suggest a need for follow-up understory prescribed burning



Landscape Vegetation and Wildlife Habitat

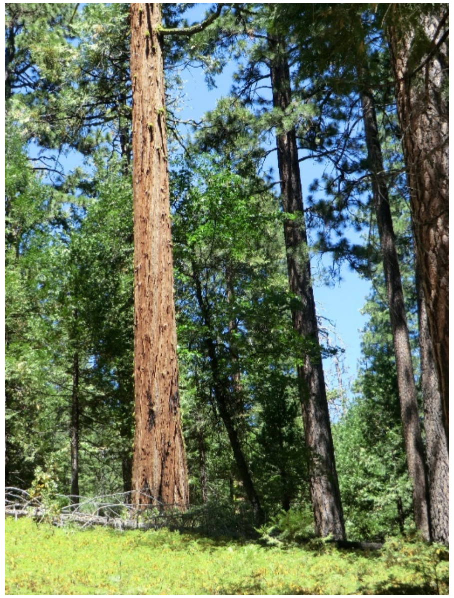
Vegetation: Lead Investigators Charles Maxwell and Angela White with data analysis assistance from Tim Holland

Biodiversity: Lead Investigator Angela White
Old Forest associated predators : Lead Investigator Keith Slauson

Forest composition change due to warming

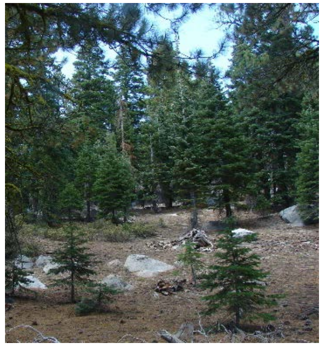
- Changes are driven by climate change
- Management can temper some of the changes (e.g., Scenario 3 reduces white fir and increases aspen)
- These dynamics are uncertain (especially due to uncertainty in climate projections)
- These results do suggest opportunities for (adaptive) management to promote resilience, especially in upper montane (redfir) forests as well as aspen stands

Incense-cedar
White pines

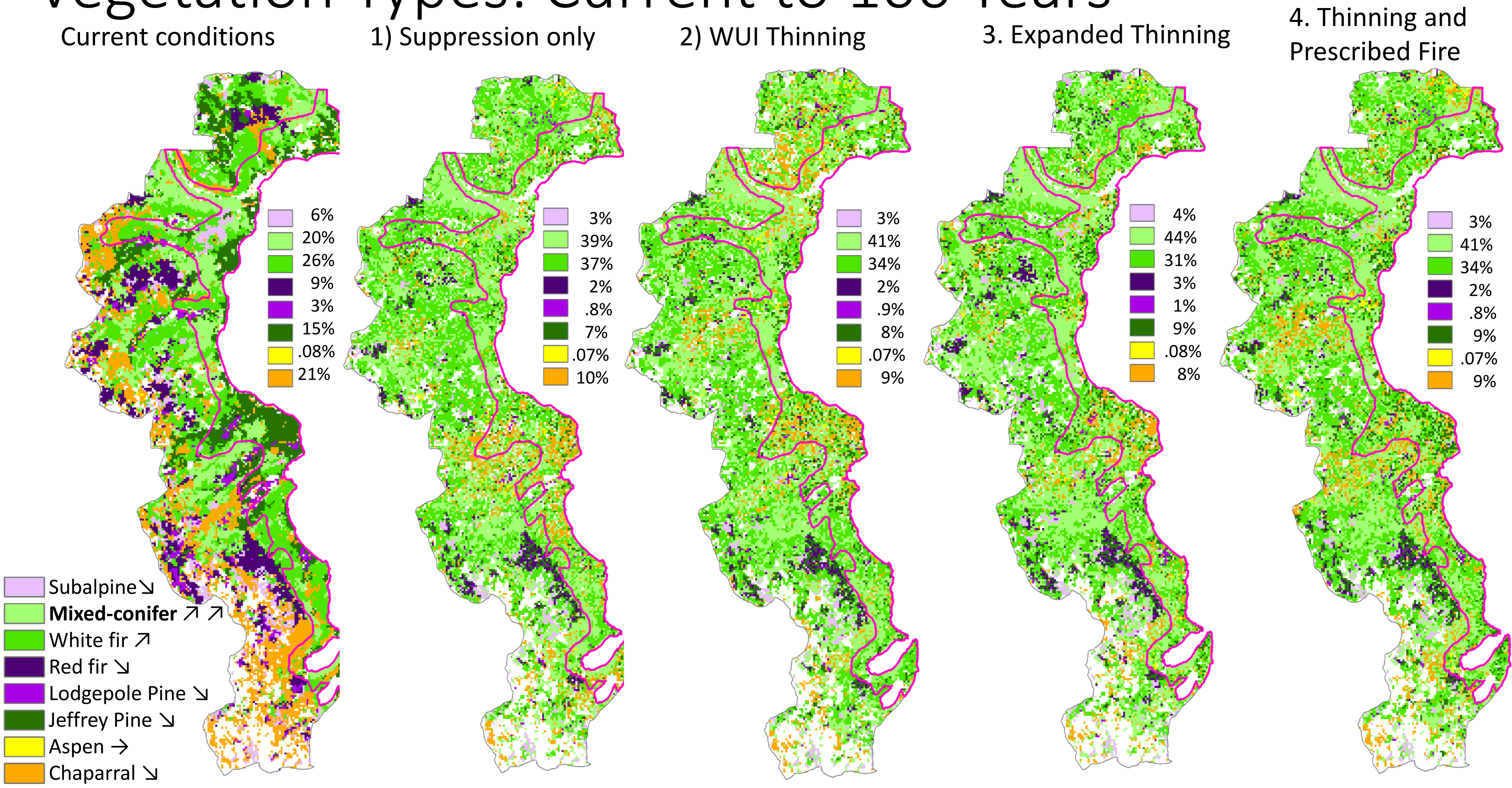


White fir

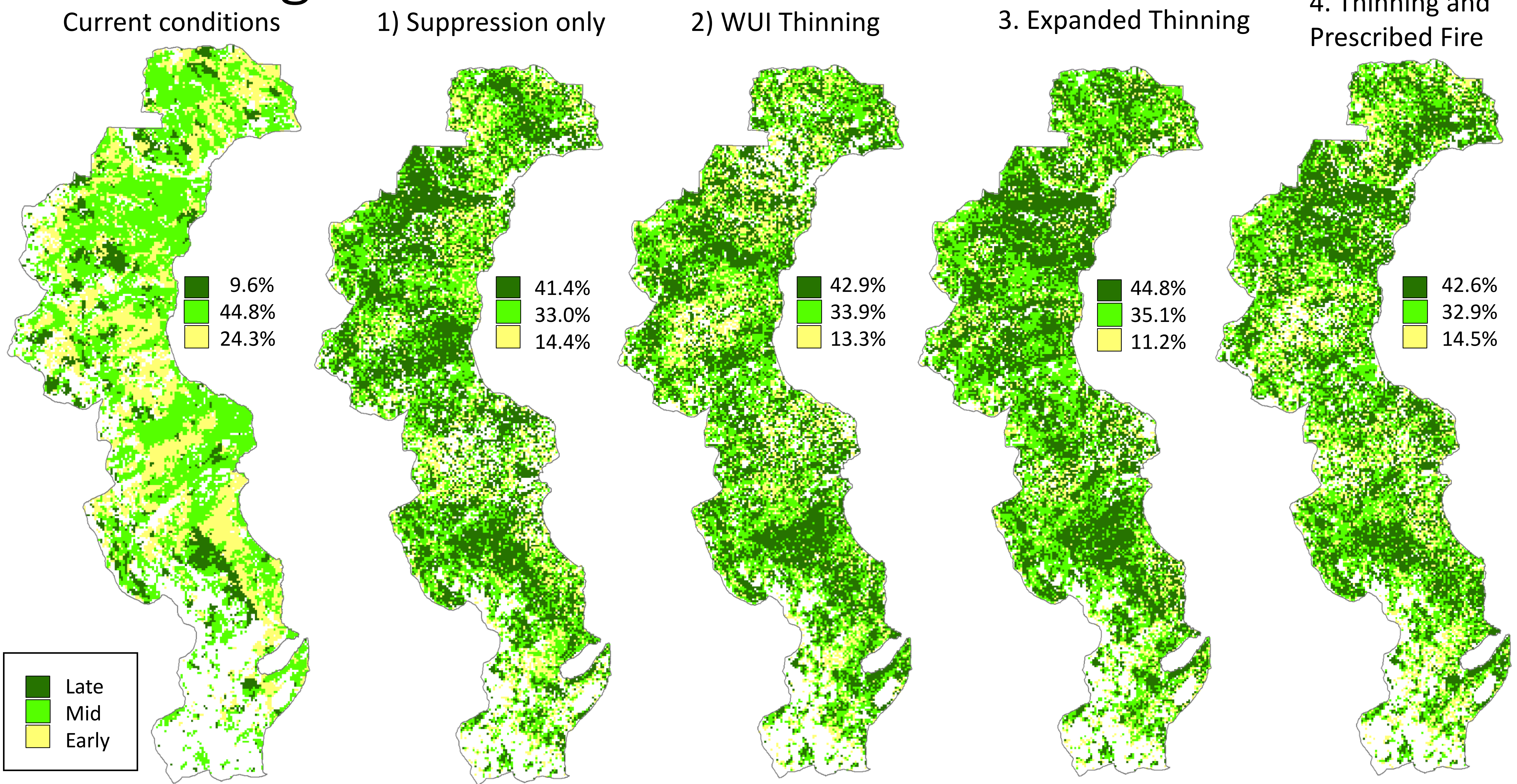
Redfir
Jeffrey pine
Lodgepole pine
Aspen



Vegetation Types: Current to 100 Years

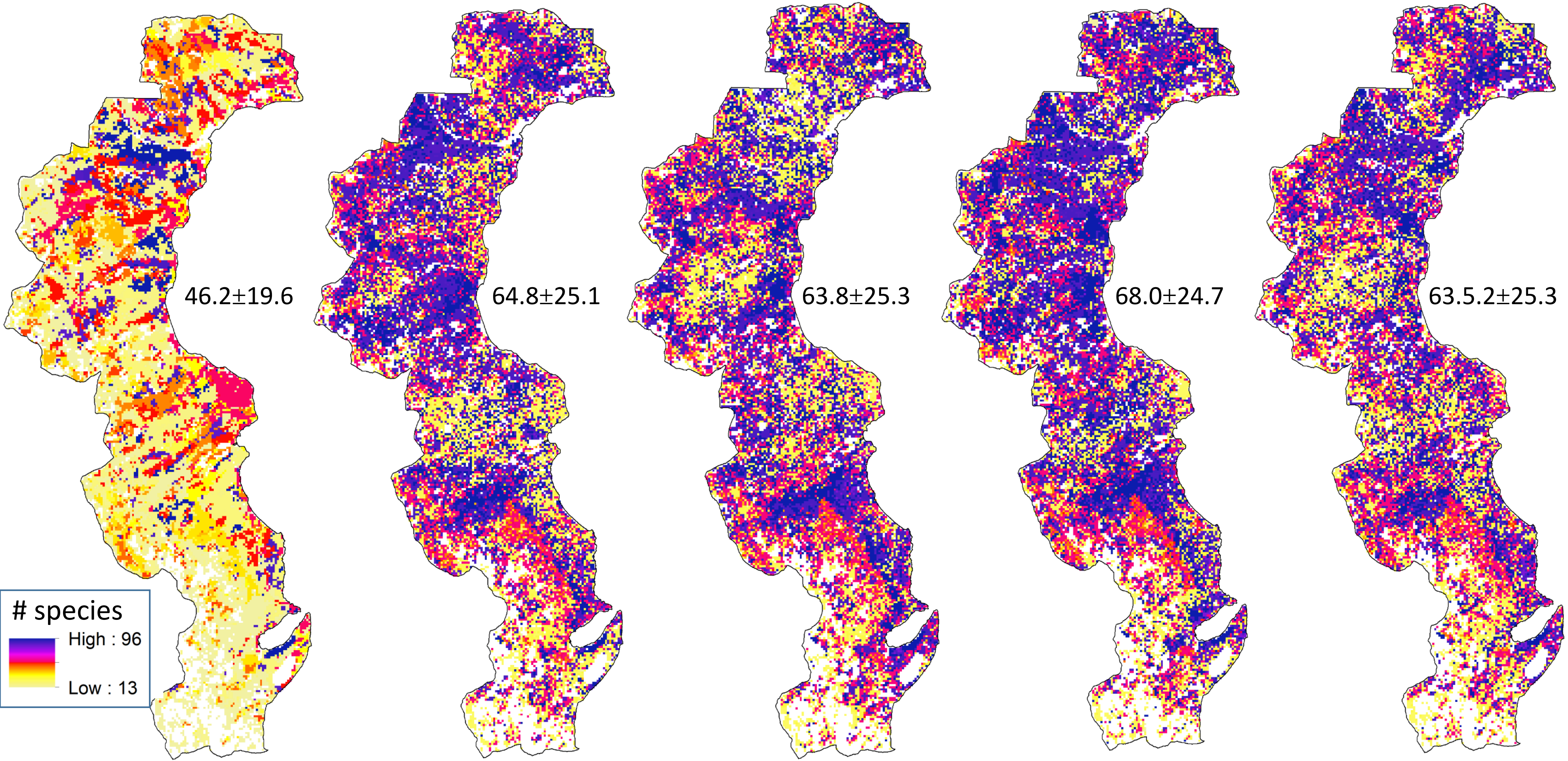


Seral Stage: Current to 100 Years



Species Richness: Current to 100 Years

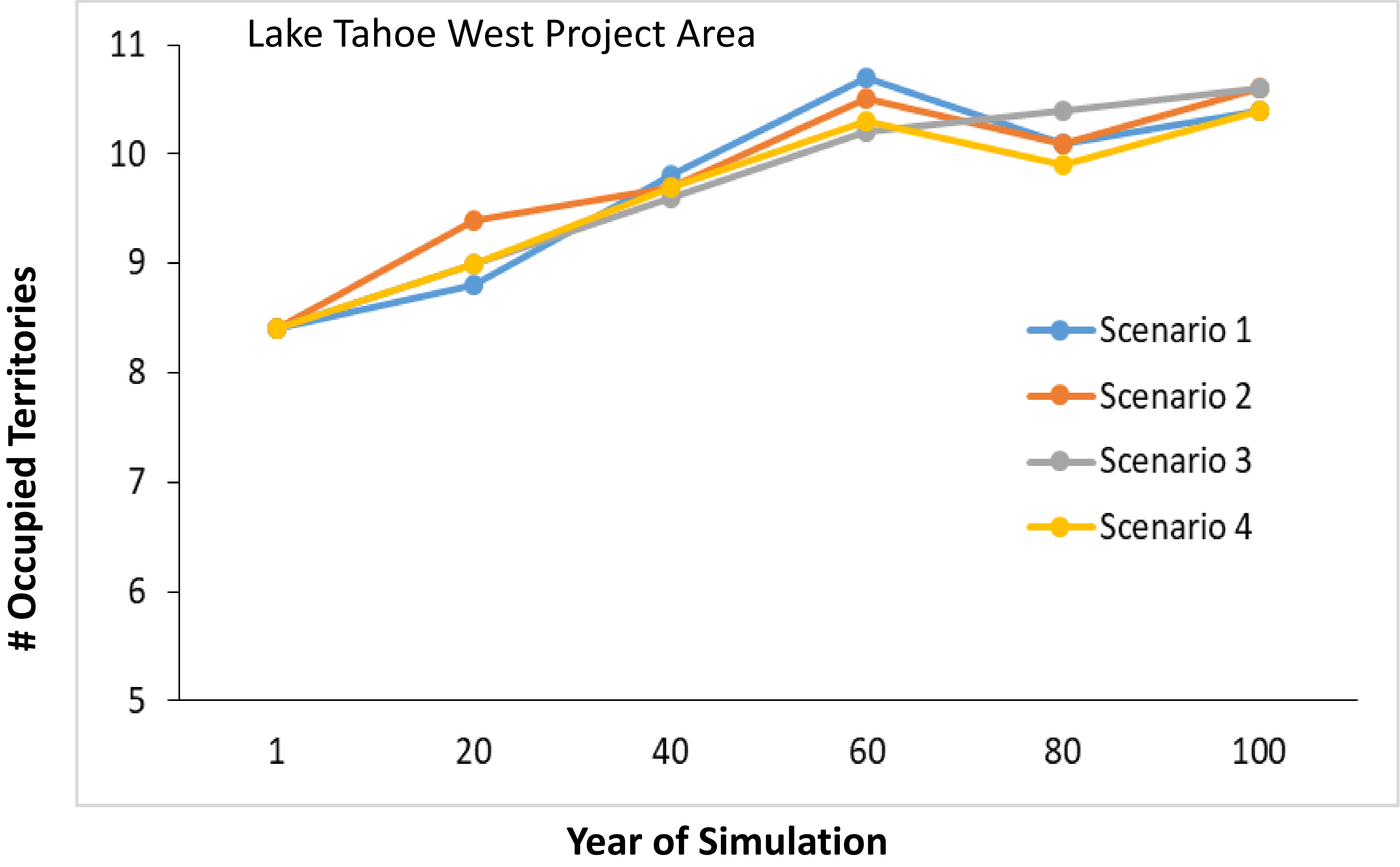
Current conditions | 1) Suppression only | 2) WUI Thinning | 3. Expanded Thinning | 4. Thinning and Prescribed Fire



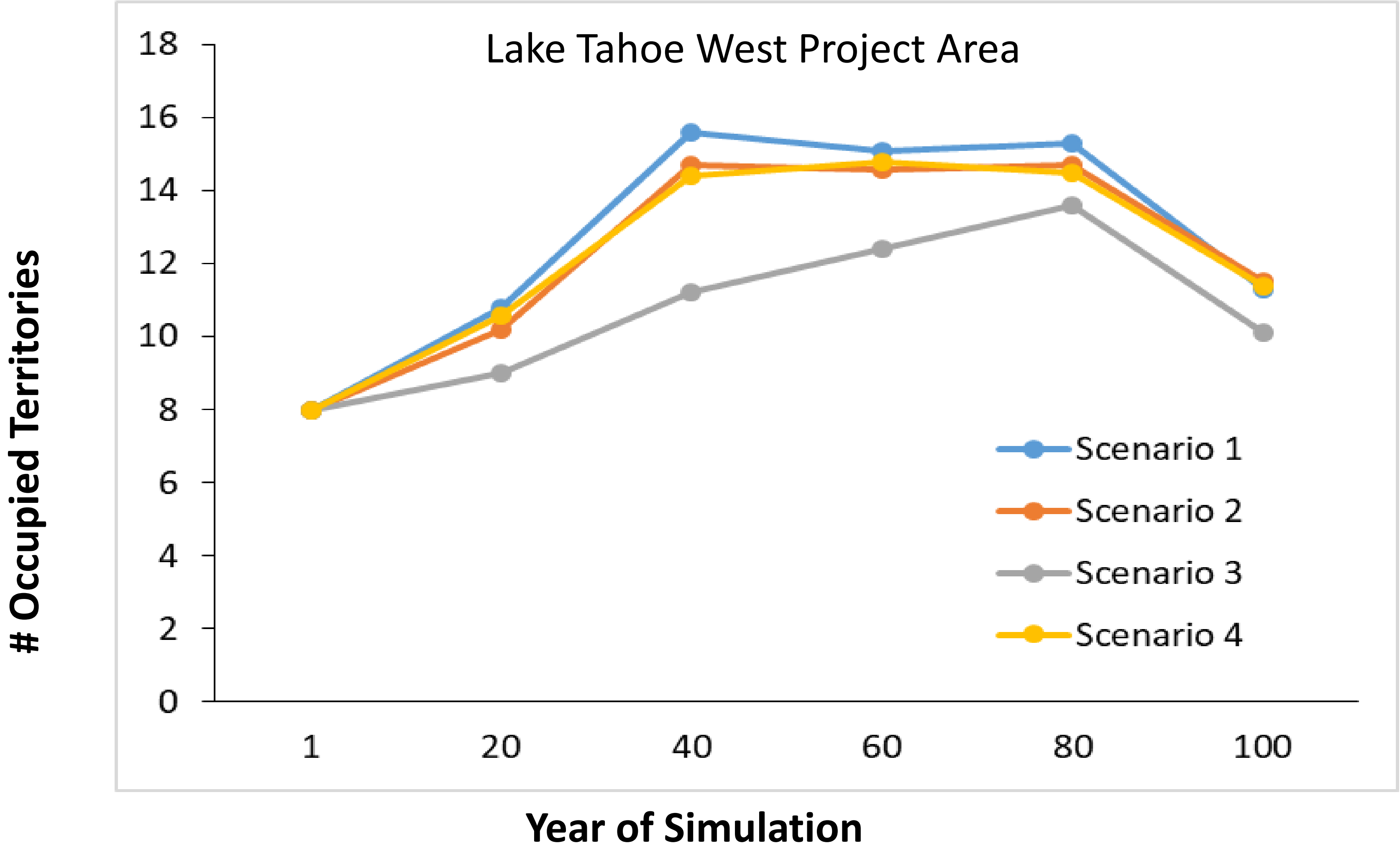
Old Forest Predator Modeling
Key Points

- Recruitment of old forest across the basin appears to be a bigger factor than the differences in the scenarios for all 3 old forest associated predators
- While territories increase under all scenarios, scenario 3 yielded slightly more territories for martens and somewhat fewer for owls
- Attention will be needed to develop mechanical thinning approaches in lower elevation forests capable of maintaining or improving conditions for spotted owls and potentially to monitor their effects

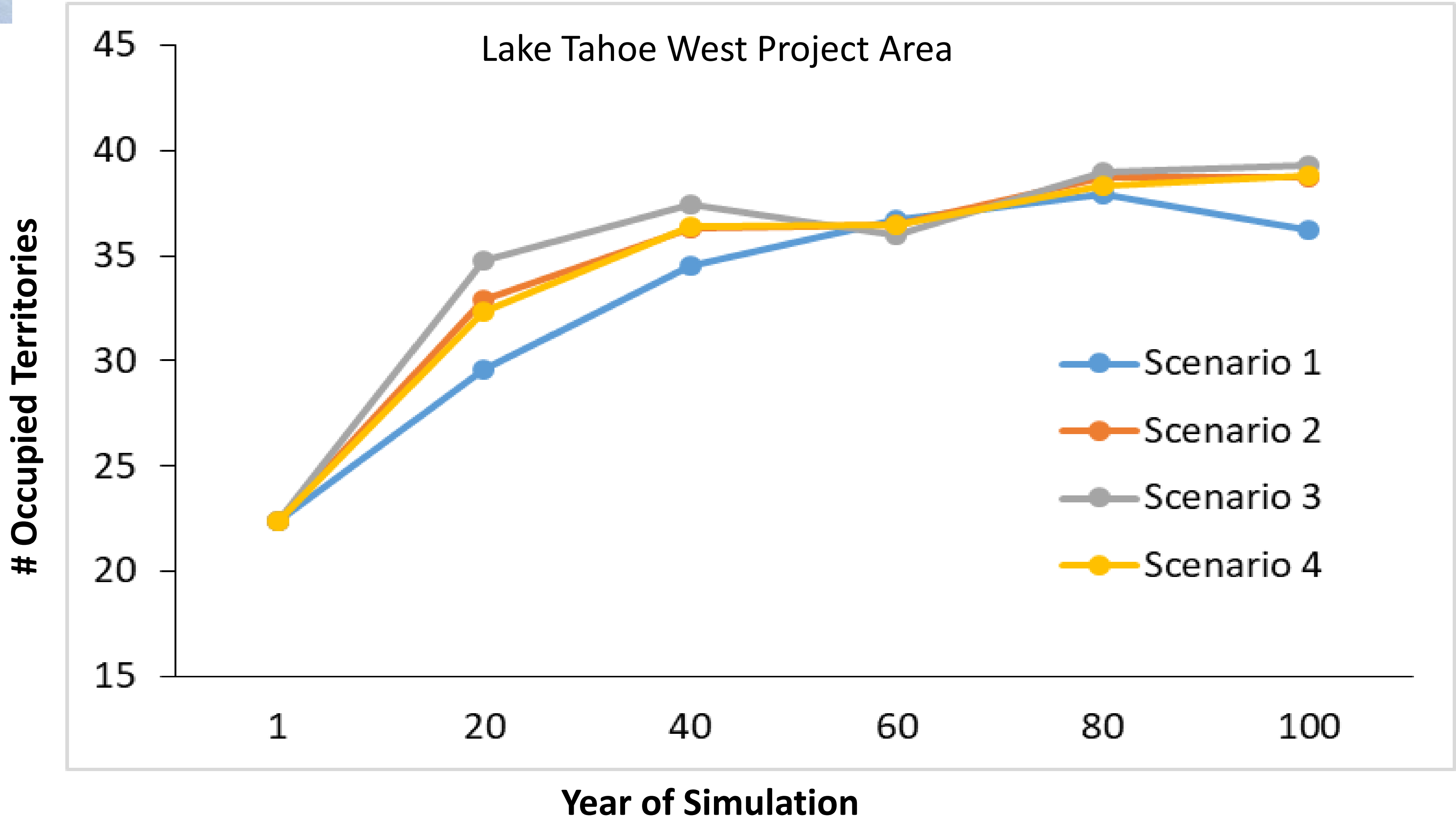
Occupied Northern Goshawk Territories Increase ~25% from Baseline



Occupied Spotted Owl Territories increase by 33-100% for 80 years, then decline to above baseline



Occupied Female Pacific Marten Territories Increase ~75% from Baseline

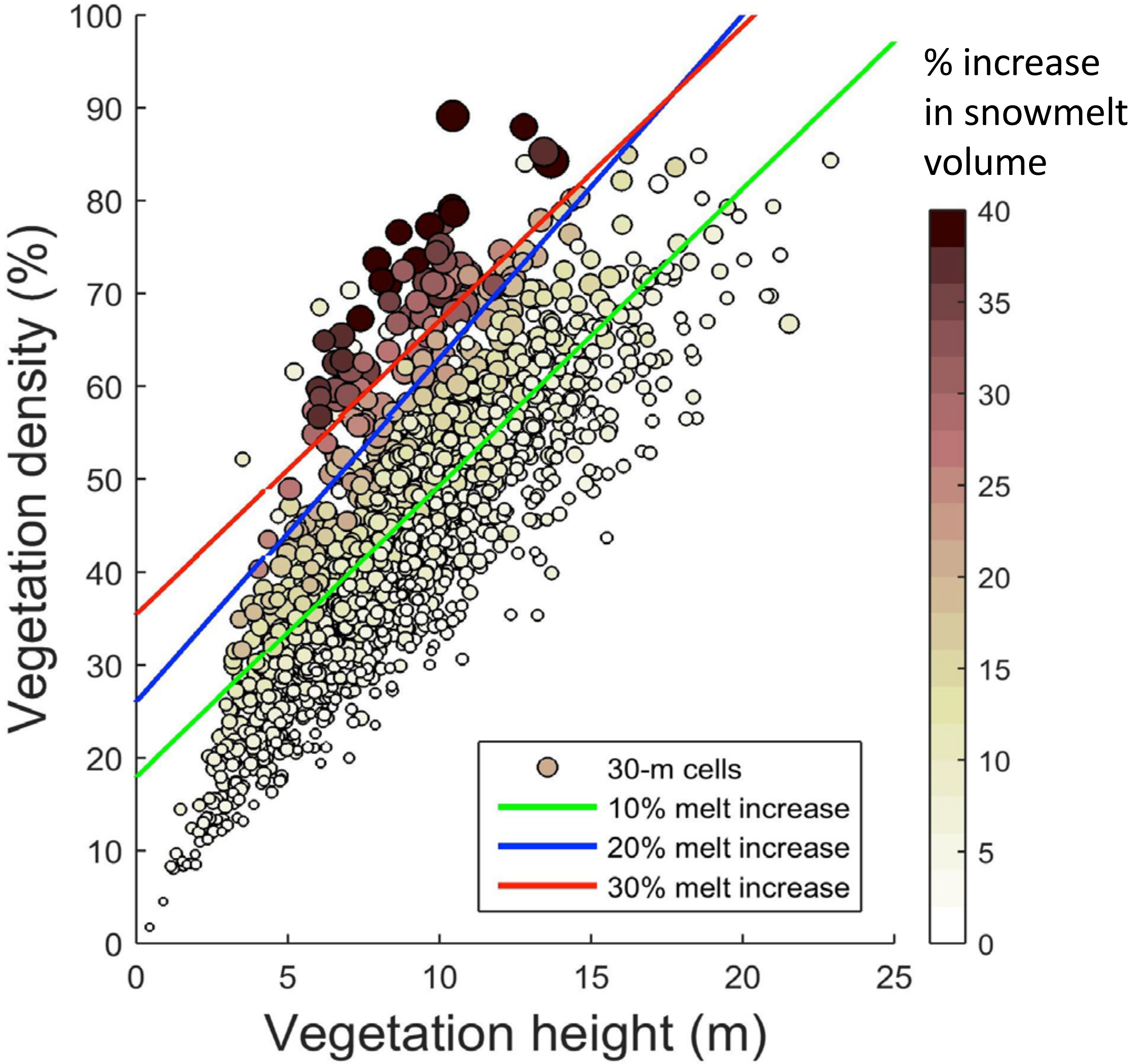


Water Quantity

Lead Investigator: Adrian Harpold

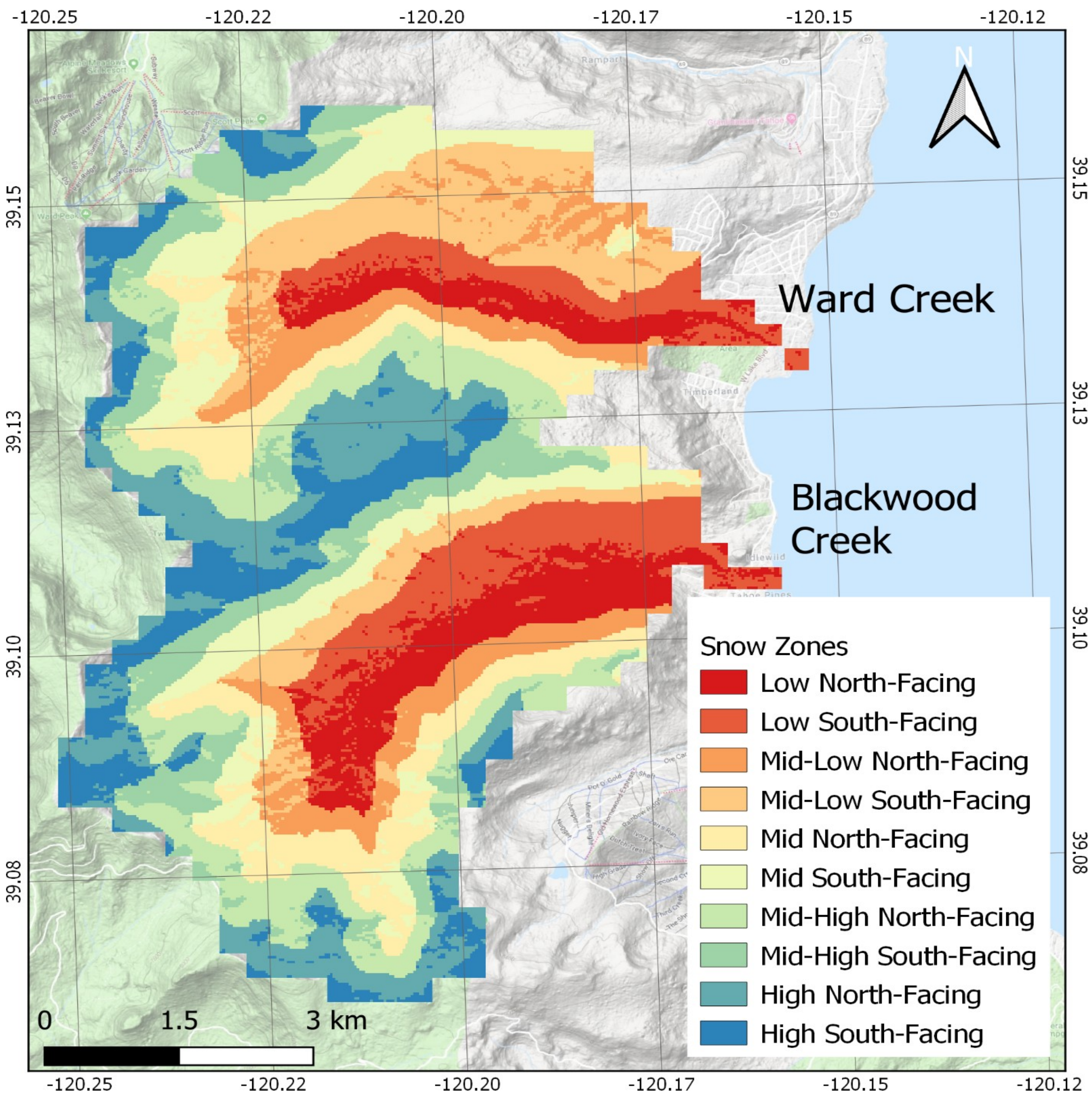
Thinning of understory trees increases water yield (snowmelt volume)

- Moderately tall, very dense forest stands are associated with greatest potential for increased water yield



Harpold et al., in prep. for *Ecohydrology*

- Effects do vary across the landscape, with a stronger response at **lower elevations**
- The team is developing a decision support tool to evaluate expected responses across 4 watersheds (Blackwood, Ward, General, and Meeks)



Water Quality—WEPP modeling

LANDIS-II

Decadal-summarized outputs:

- Thinned cells
- Burned cells (sorted by burn intensity/severity)

FSWEPP

Average hillslope yields per unit area given current condition, thinning, or fires at different severity

% Changes in yields of

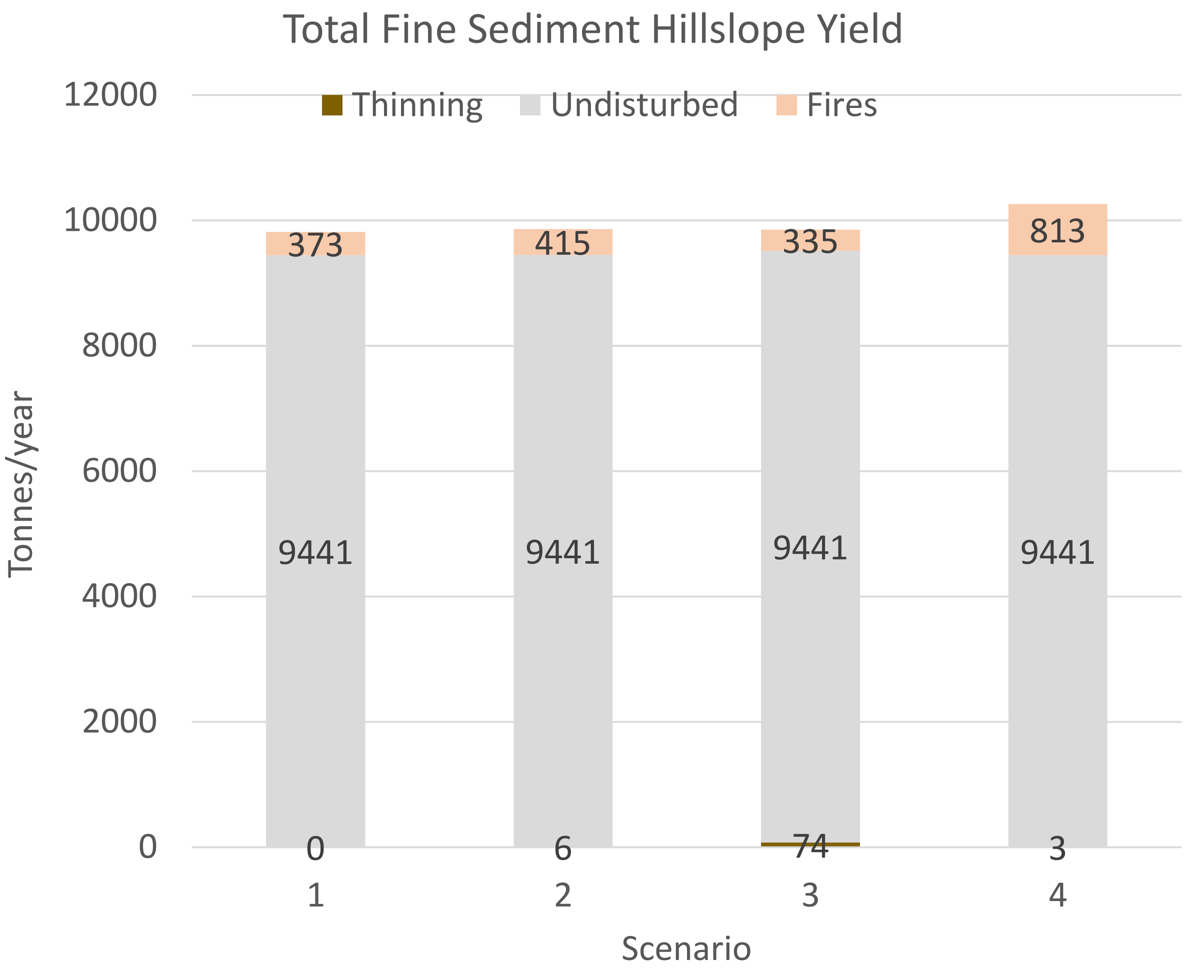
- Total Phosphorus
- Very fine Sediment (<16 microns)

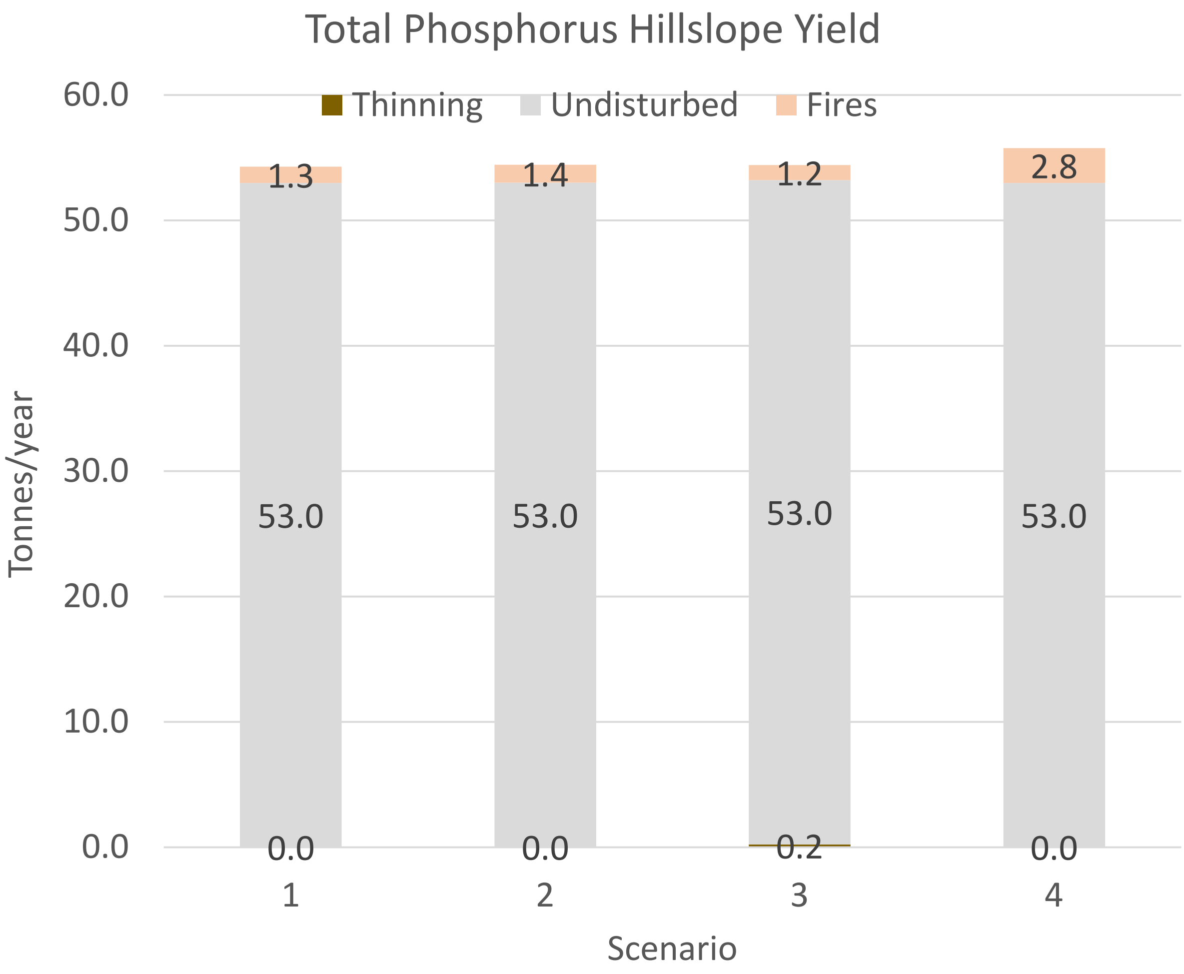
Lead Investigators: Mariana Dobre, Bill Elliot, Erin Brooks

LANDIS Overlay and Analysis: Mason Bindl, Jonathan Long

Expected load increases due to fires are much larger (5-300X) than increases from thinning

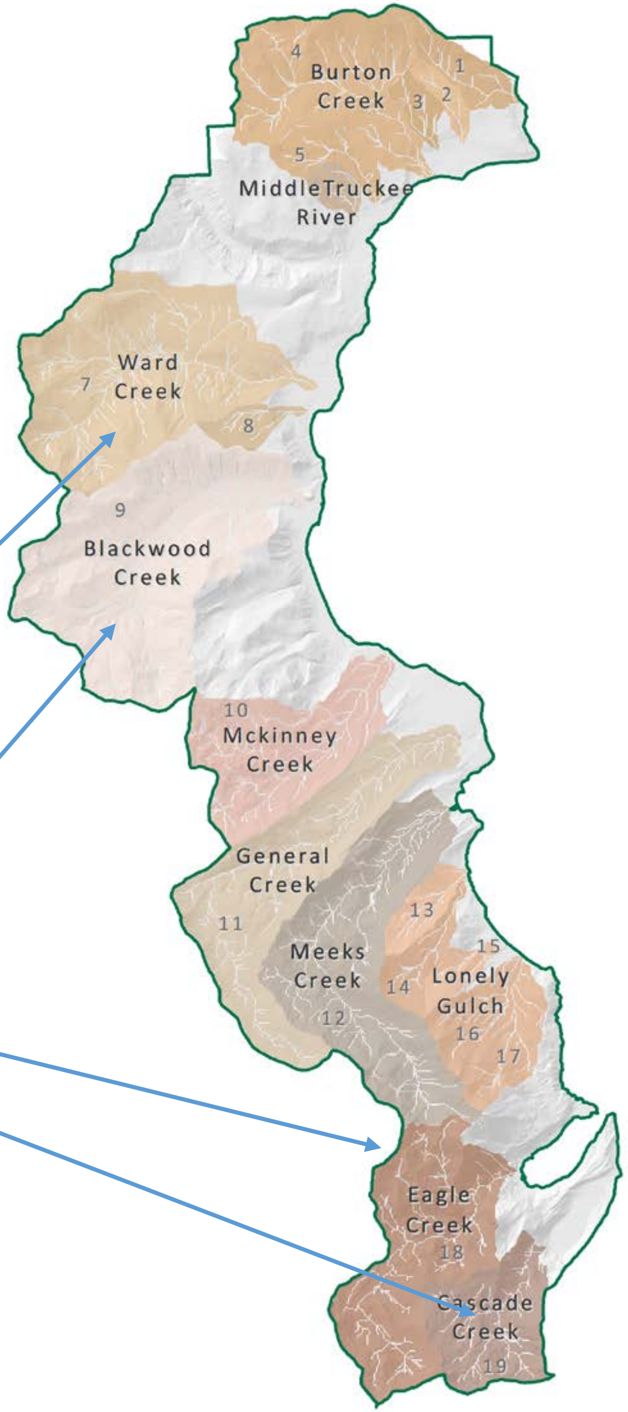
Expected load increases due to fires are relatively small (4-10%) compared to background





Major source watersheds of fine sediment and phosphorus include:

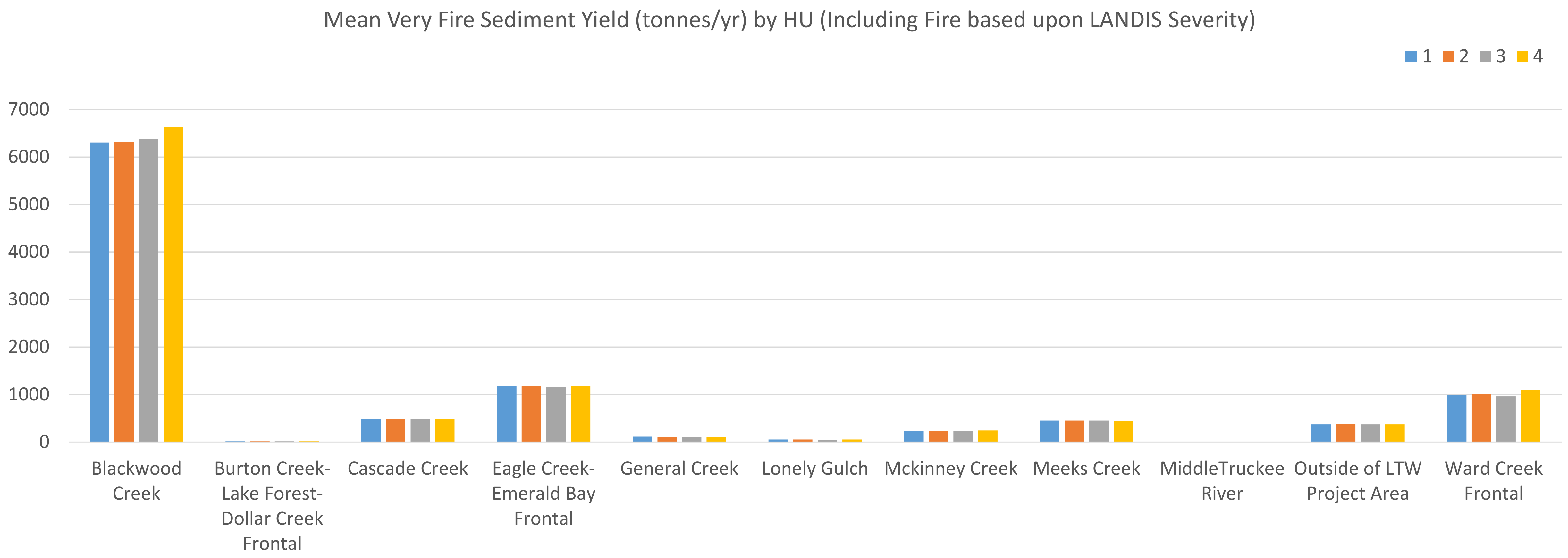
Ward
Blackwood
Eagle
Cascade



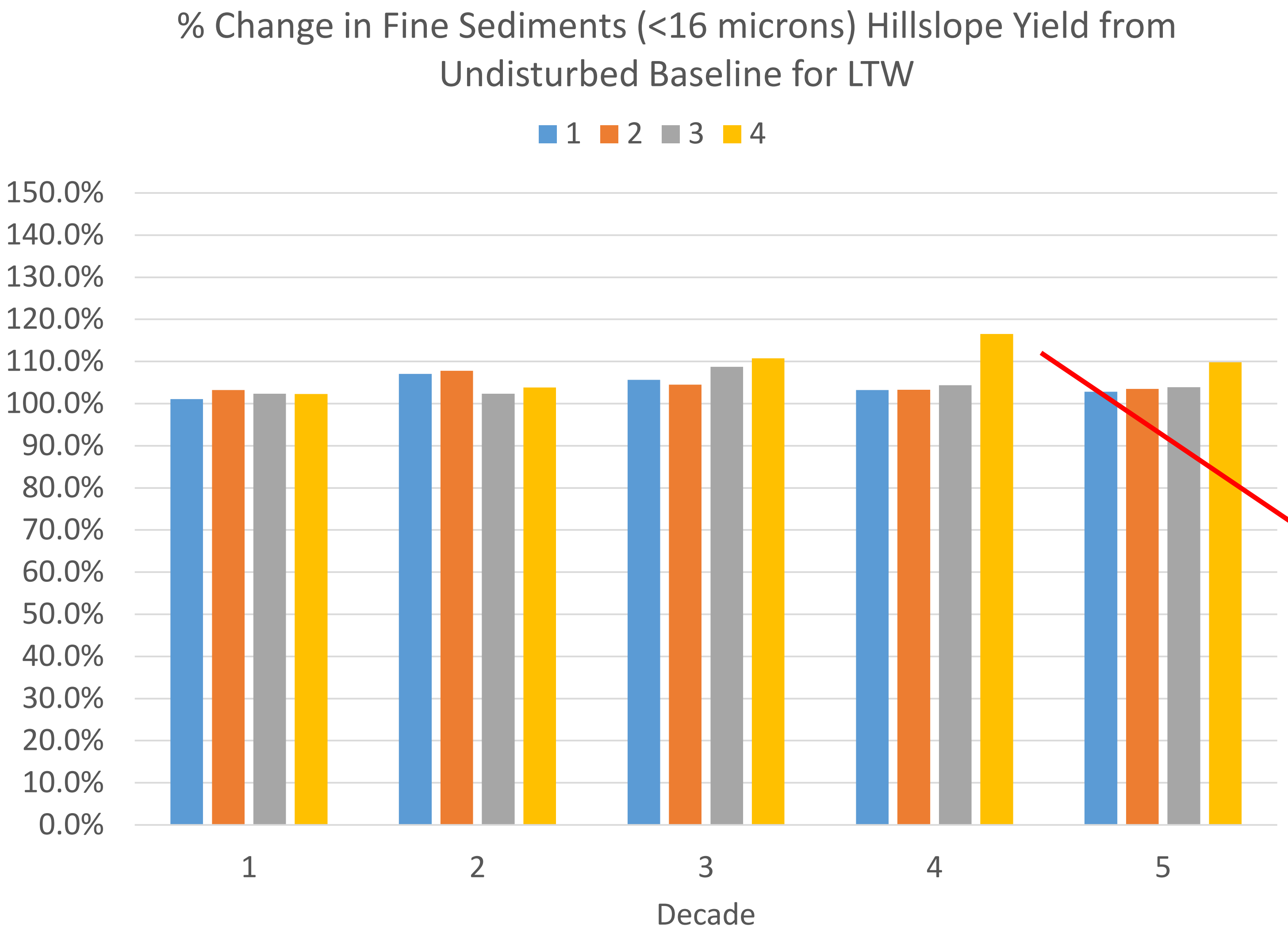
Results from WEPP modeling of current condition

Watershed Name	Area (ha)	% of Modeled Area	% of Sediment Discharge	% of Very Fine Sediment Yield	% of Total Phosphorus discharge
Dollar	262.83	1.6%	0.1%	0.0%	0.2%
Lake Forest	110.68	0.7%	0.0%	0.0%	0.0%
Barton	188.22	1.2%	0.1%	0.0%	0.1%
Burton	1345.08	8.2%	1.2%	0.2%	1.5%
Tahoe State Park	268.63	1.6%	0.1%	0.0%	0.2%
Unnamed	122.51	0.7%	0.0%	0.0%	0.1%
Ward	2314.23	14.2%	12.1%	12.5%	12.2%
Unnamed	160.26	1.0%	0.1%	0.0%	0.1%
Blackwood	2671.07	16.4%	36.3%	56.6%	34.9%
McKinney	1309.41	8.0%	7.9%	4.1%	7.9%
General	1819.7	11.1%	2.0%	0.7%	2.7%
Meeks	1981.45	12.1%	6.1%	2.1%	6.6%
Sierra	211.44	1.3%	0.1%	0.0%	0.1%
Lonely Gulch	246.15	1.5%	1.0%	0.0%	1.1%
Paradise Flat	149.32	0.9%	1.5%	0.3%	1.4%
N. of Rubicon	295.18	1.8%	2.2%	0.4%	2.2%
Rubicon	386.9	2.4%	4.2%	0.7%	4.1%
Eagle	1647.08	10.1%	16.4%	8.5%	16.0%
Cascade	845.73	5.2%	8.9%	13.9%	8.8%
Total	16335.87				

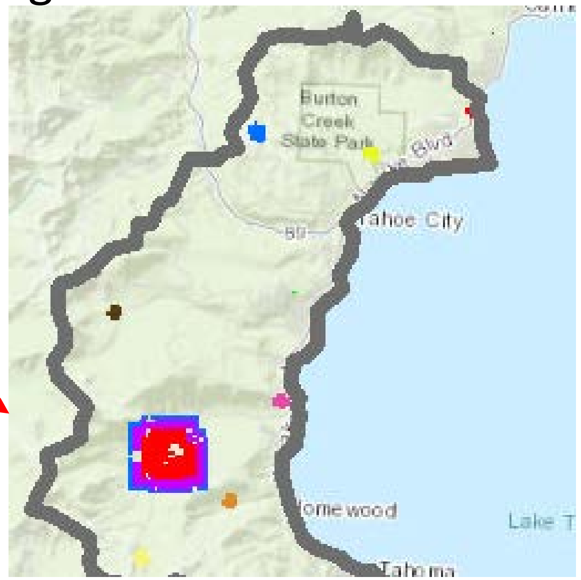
Differences in loads by scenario are dominated by changes in Blackwood and Ward watersheds



Results are sensitive to stochastic, extreme events in highly erodible areas



Wildfire in Blackwood Canyon in Scenario 4 in model year 30 results in high loads



Water Quality—WEPP Road Modeling

Lead Investigators: Sue Miller, Bill Elliot

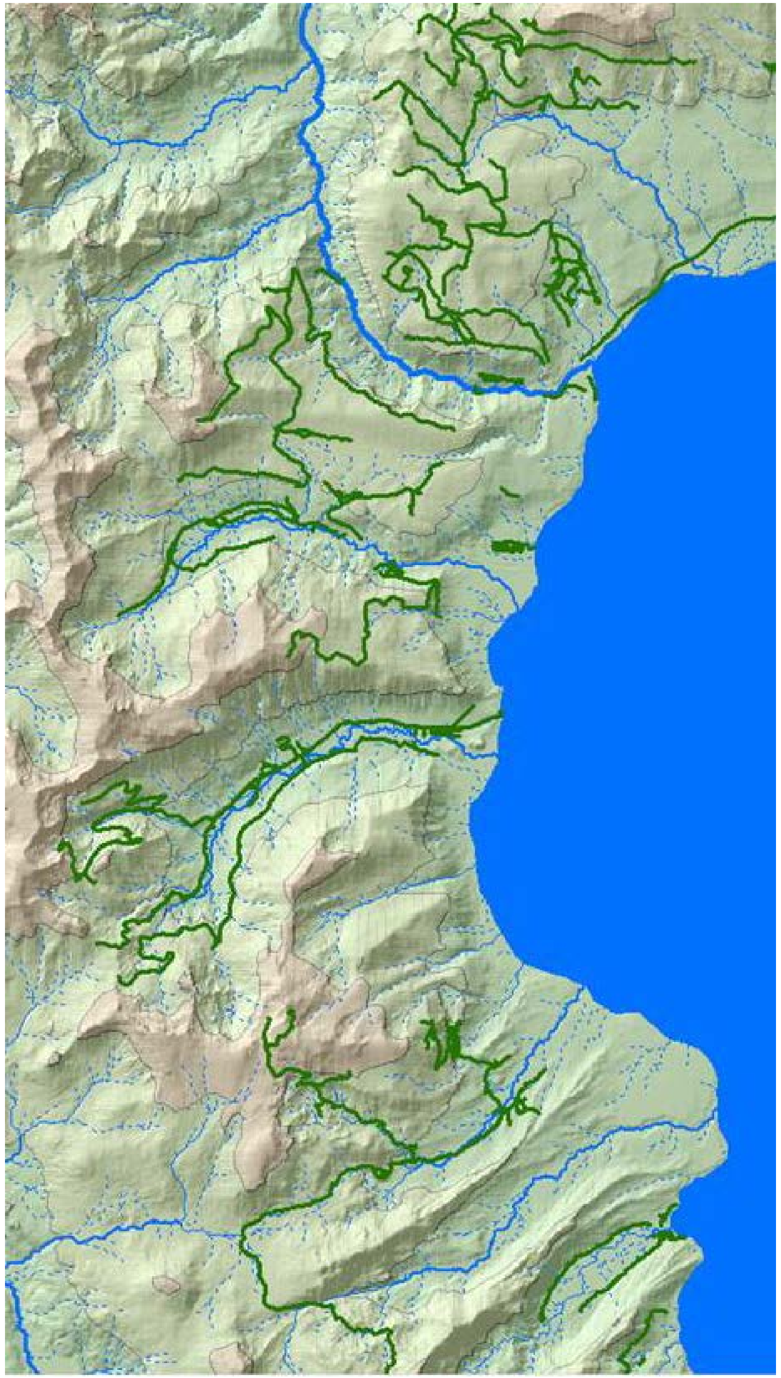
Forest Roads and Water Quality

- Generally, the forest road system in Lake Tahoe is well-maintained, so risks to water quality appear comparatively low on most segments.

Modeled sediment delivery in metric tons to channels under current condition

Sediment (Mg)

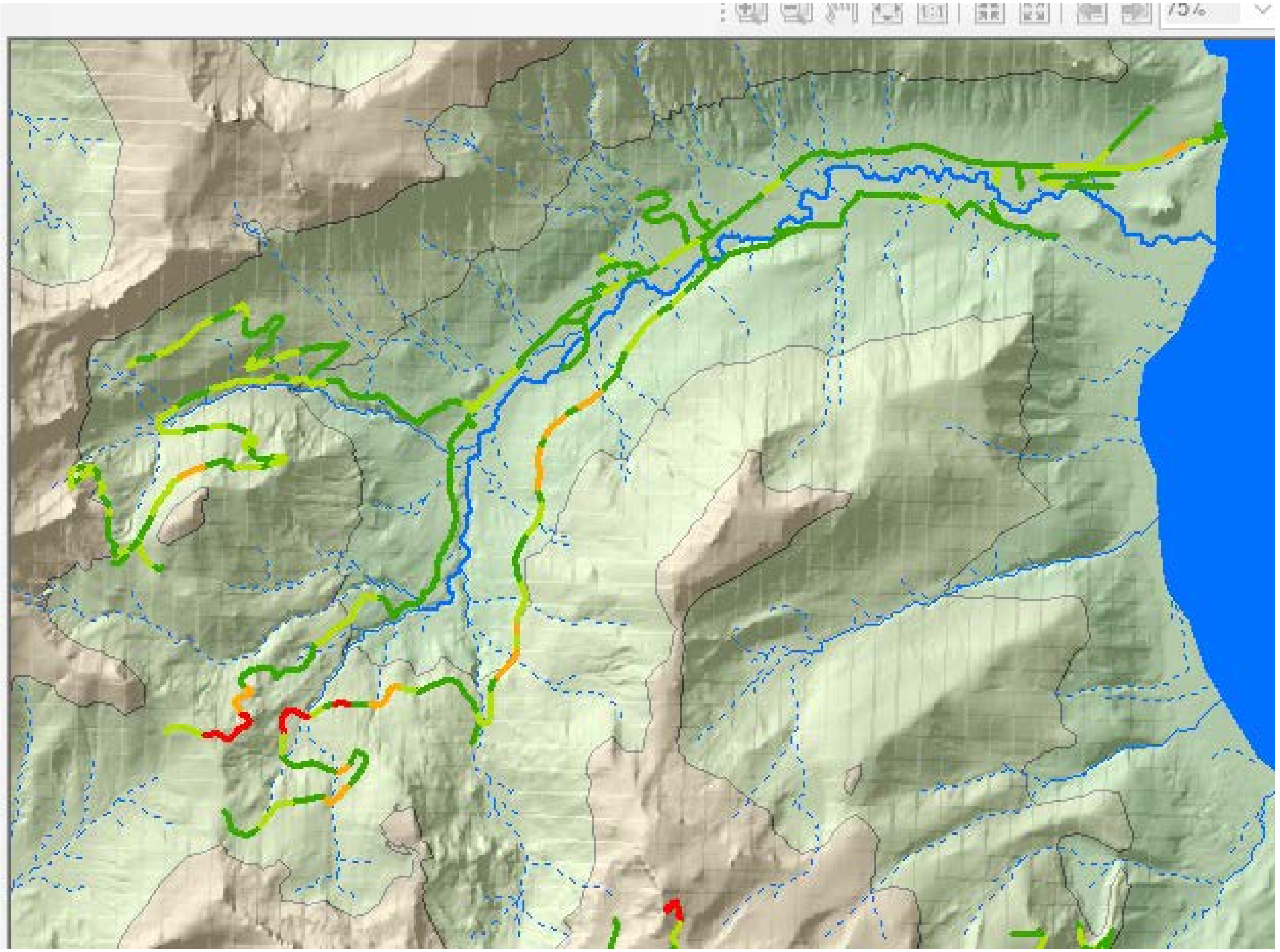
- 0-1
- 1-2
- 2-3
- >3



Forest Roads and Water Quality

- Some segments pose higher risk (due to steep slopes and erodible soils)
- Investigate these segments to evaluate actual risks and load reduction opportunities

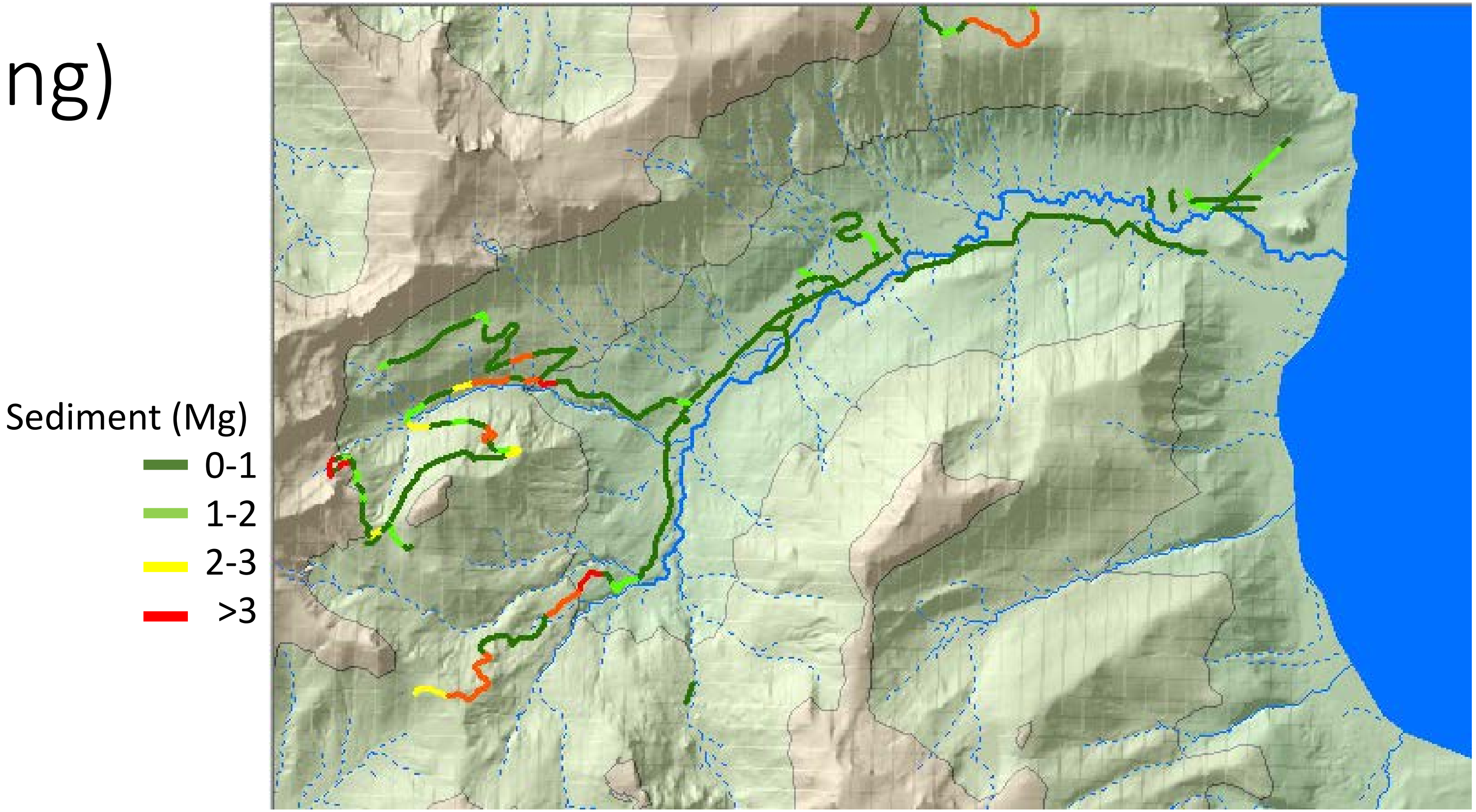
Sediment (Mg)
- 0-0.04
- 0.04-0.16
- 0.16-.40
- 0.40-0.86



Modeled sediment delivery to Blackwood Creek under current condition

Roads have elevated sediment delivery during active use
(e.g., for thinning)

- Risks generally diminish rapidly once the use has ended
  - by 80% within 1 year
  - by more than 90% following revegetation



Modeled sediment delivery to channels during active use of forest road network for removal of biomass

Roads and Water Quality: Implications

- Effects of reopening legacy roads, creating new temporary or long-term roads, and closing or removing old roads are highly dependent on specific landscape contexts.
- The tools we have developed can evaluate such effects at finer scales (i.e., watersheds) using specific alternative proposals.

Air Quality

Broad-scale (full century)

Snapshot events from 2039

- Health impacts are very uncertain due to variable weather and resulting population exposure
- Daily emissions are therefore a useful proxy indicator for health impacts

Daily emissions outputs → Smoke modeling → Economics modeling

LANDIS-II

BlueSky

BenMAP

Charles Maxwell

Stacy Drury

Sam Evans

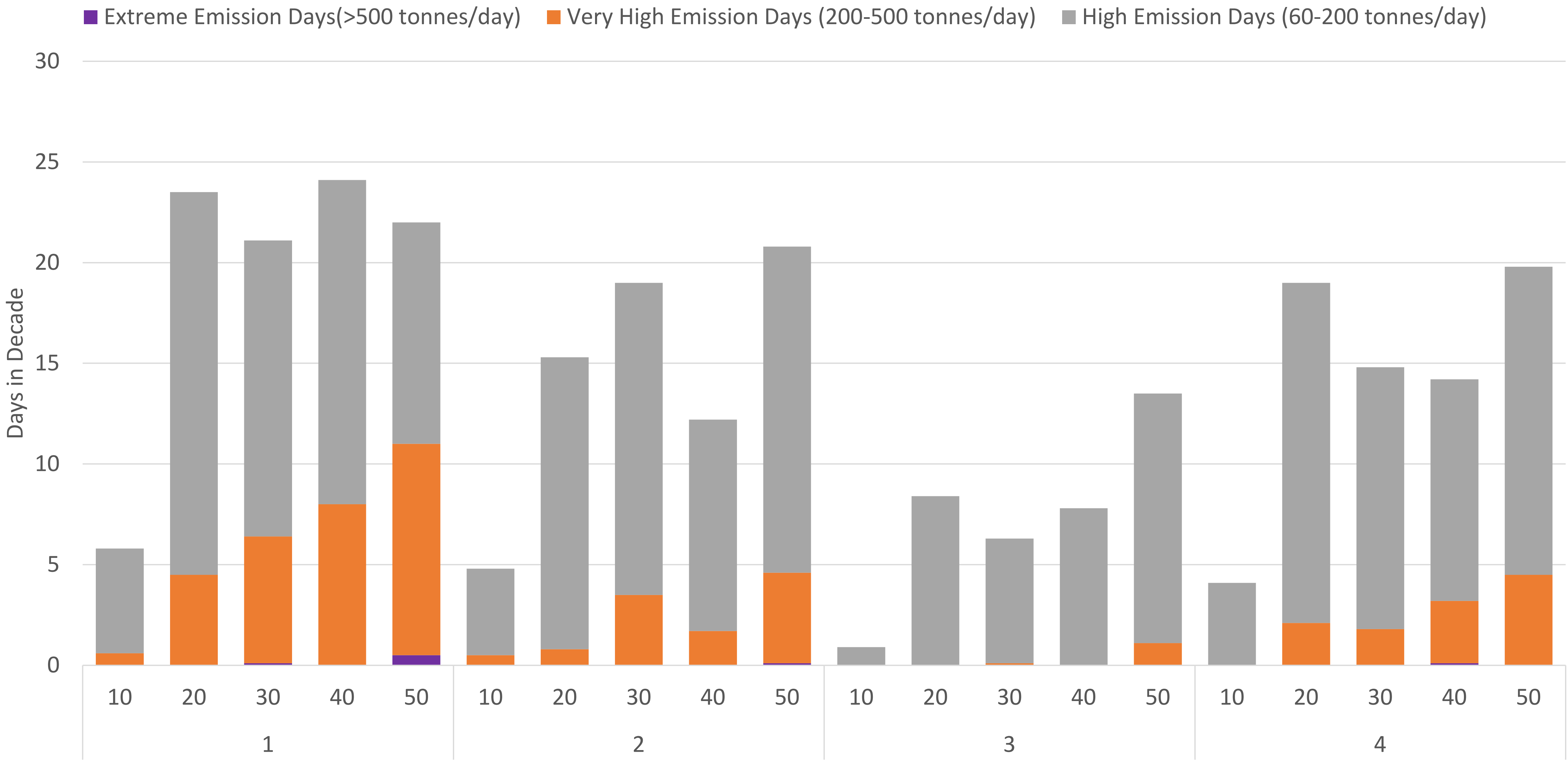
Jonathan Long (integration and indicator evaluation)

1) daily emissions	2) conveyance to downwind communities	3) size and vulnerability of those communities

Key Findings from Emissions

- Modeled treatments reduce fuel consumption, leading to lower overall emissions and fewer days of high emissions, *but there is much variation in individual smoke events and resulting impacts*
- Pile burning is a very minor contributor to days with high emissions, although it represents many burn days and total emissions of PM2.5
- Prescribed burning results in moderate emissions, which could have measurable impacts even while if they remain within regulatory limits due to their frequency
- However, managers may also be able to time and manage such burns to minimize impacts in ways that broad-scale modeling can't capture well
- Further analysis of the extent, frequency, and consumption/emissions associated with prescribed burns would help to evaluate tradeoffs better

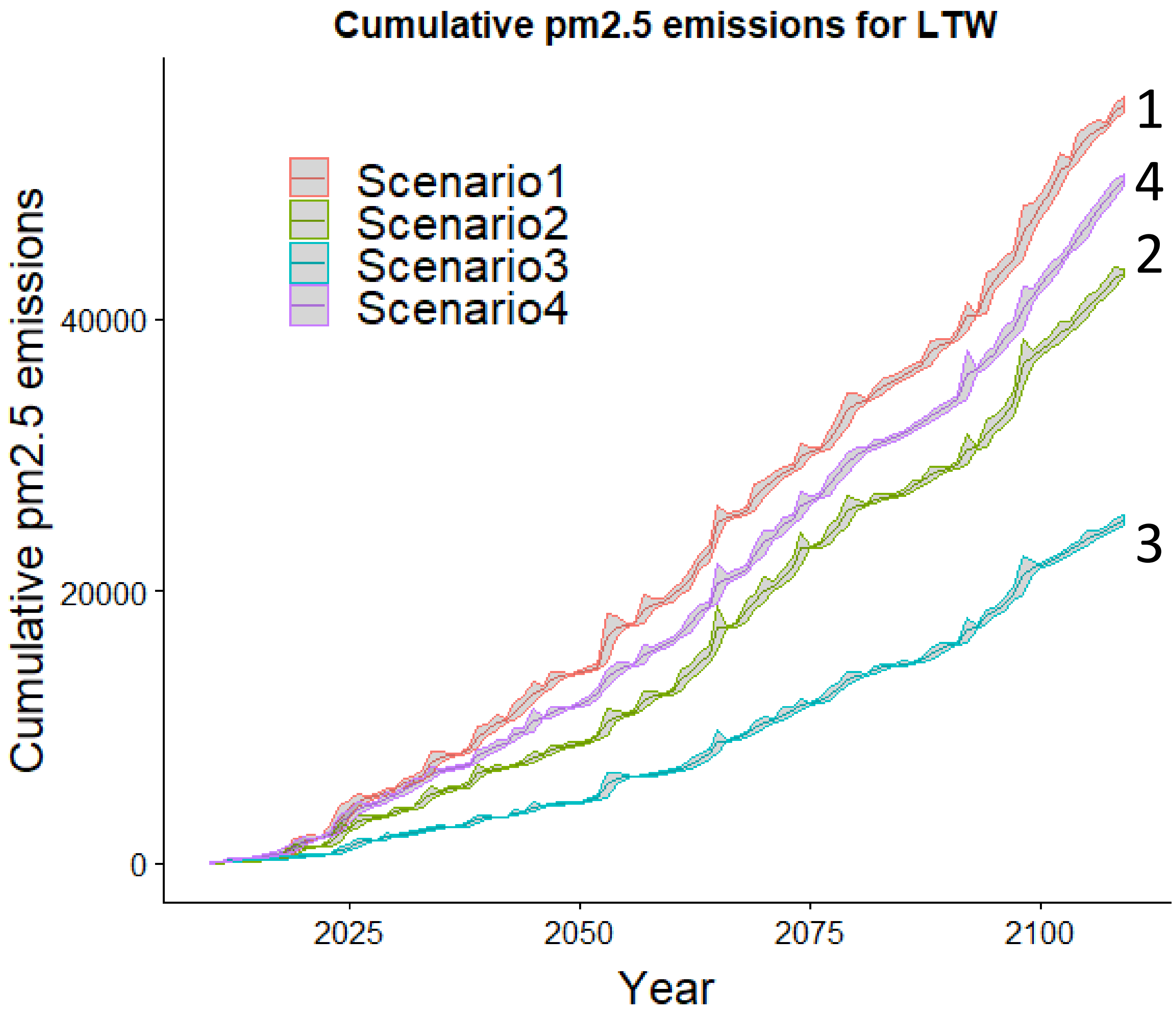
Days with High to Extreme Emissions



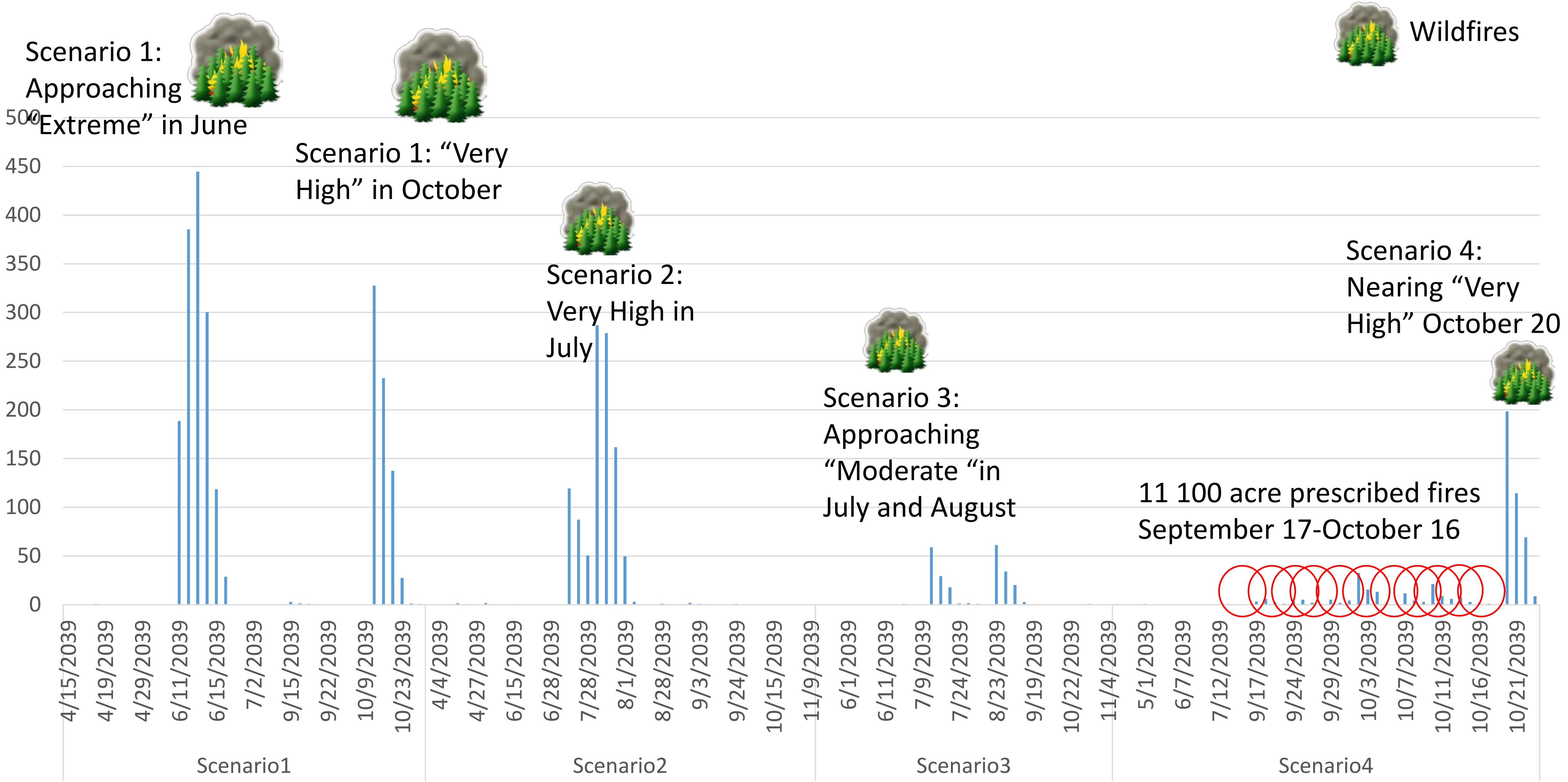
Total Particulate Emissions by Scenario

- Scenario 3 performs best in terms of overall emissions reductions
- Scenario 1 is worst
- Scenario 4 has higher emissions than 2

Daily emissions are a more socially important indicator than total emissions



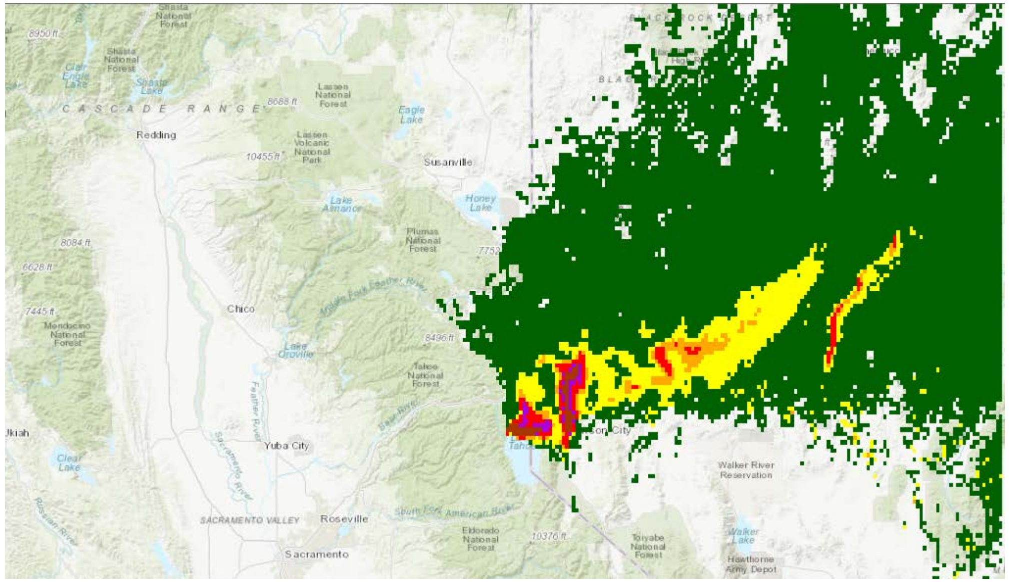
Example Year of Daily Emissions (2039) by Scenario



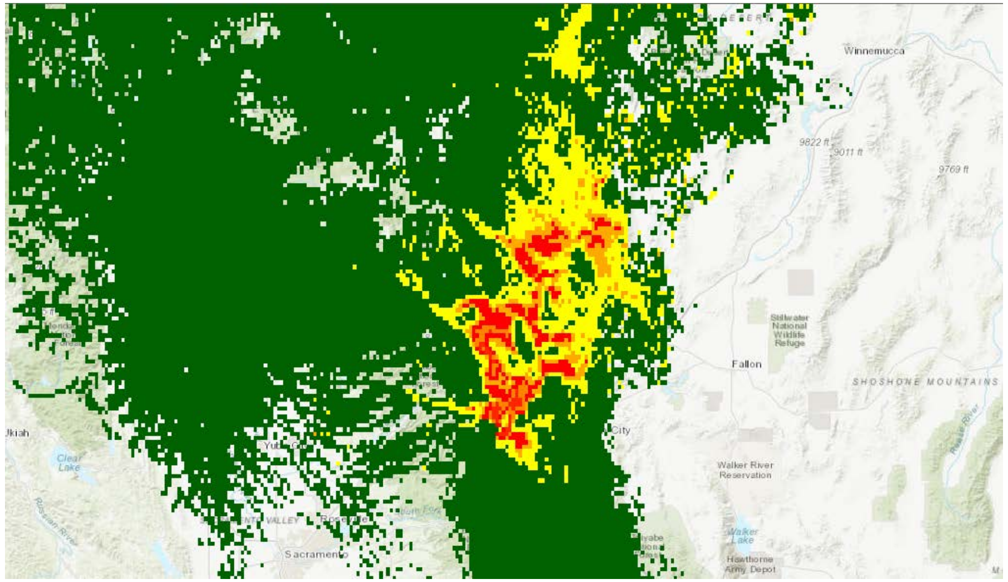
Smoke impacts occur when smoke is high and spreads over populated areas

Scenes are single representative wildfires from 2039 model results with 2018 weather

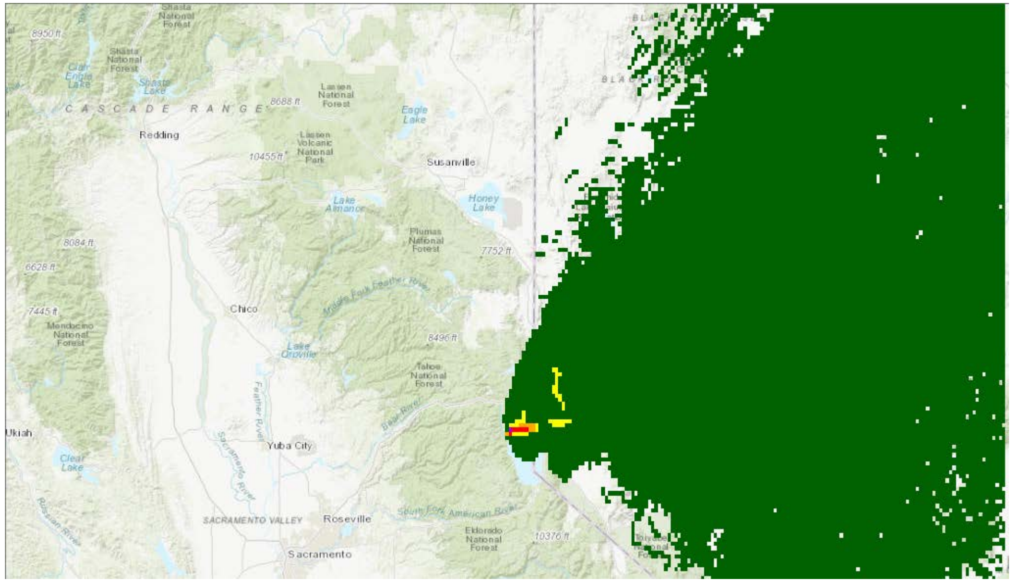
Category	$PM_{2.5}$ (µg/m³) 24-hour
Good	0.0-12.0
Moderate	12.1-35.4
Unhealthy for Sensitive Groups	35.5-55.4
Unhealthy	55.5-150.4
Very Unhealthy	150.5-250.4
Hazardous	250.5-500.4



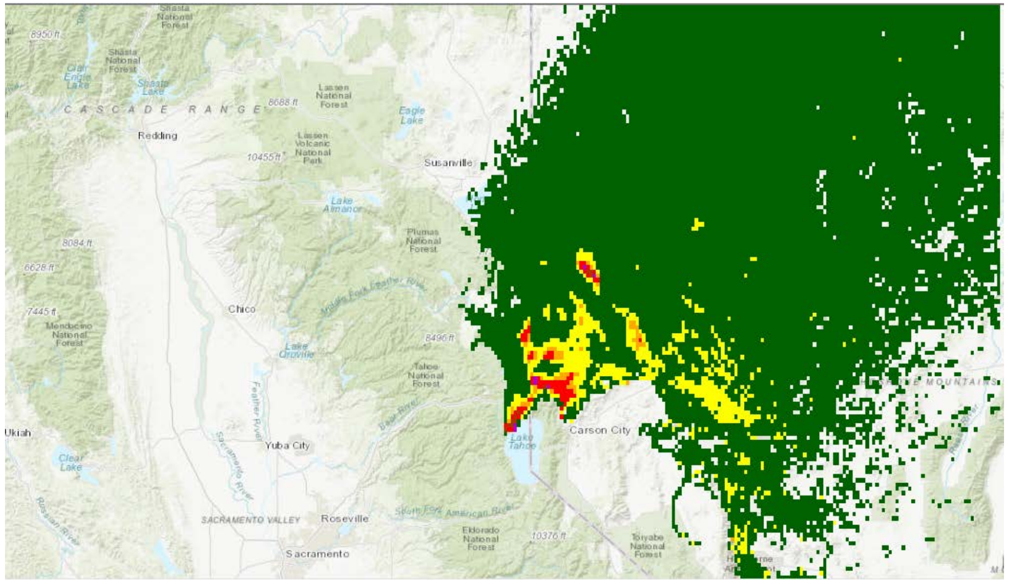
Scenario 1 wildfire (900 acres, 743 tonnes $PM_{2.5}$)



Scenario 2 wildfire (685 acres, 519 tonnes $PM_{2.5}$)



Scenario 3 wildfire (484 acres, 400 tonnes $PM_{2.5}$)



Scenario 4 wildfire (418 acres, 118 tonnes $PM_{2.5}$)

Economics

Health Impacts

Carbon

Treatment Costs and Suppression Costs

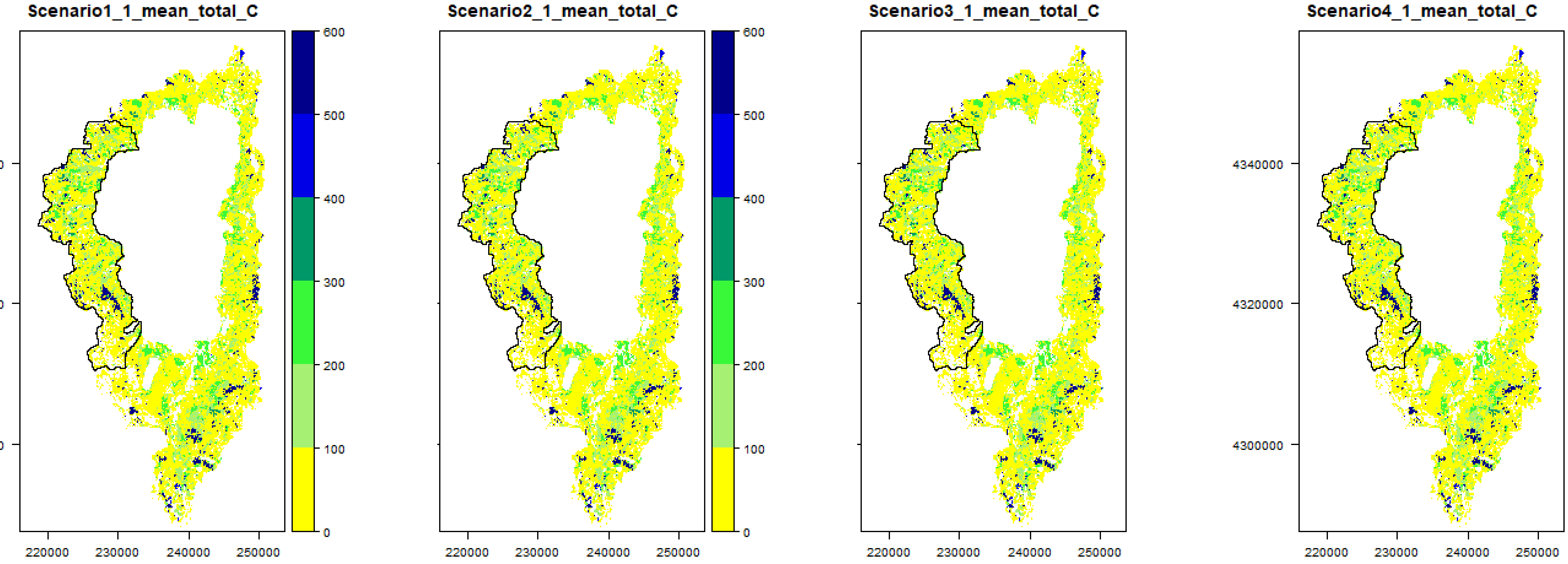
Property Risk

Economic Estimates of Smoke Impacts

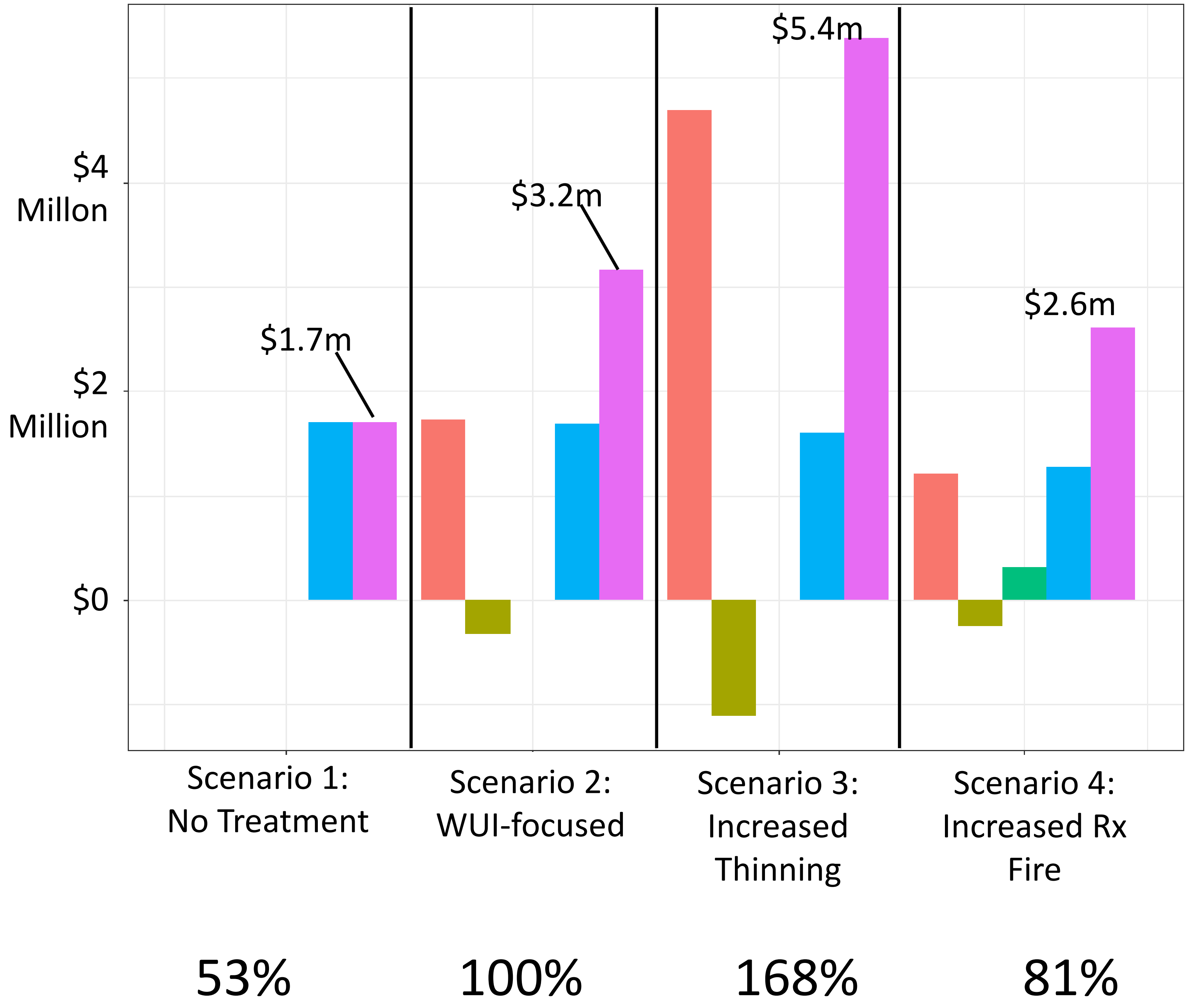
- Evaluated based upon willingness to pay to avoid health impacts (chiefly mortality risk) from smoke
- Weather conditions can cause large changes in the magnitude of impacts
- High levels of daily smoke emissions reach very large populations in Reno and/or the Central Valley
- Emissions and economic impacts from individual extreme wildfires vary widely across and within scenarios:
    - Highest: Scenario 1 (~$10M-$77 Million)
    - Lowest: Scenario 3 (~$2M-18 Million)
    - Intermediate: Scenario 2 (~$7M-$41M) and Scenario 4 ($6M-$63M)
- Individual prescribed fires *could* have substantial impacts (e.g. ~$700K)
- More analysis is needed to evaluate expected impacts from such events and overall tradeoffs for Scenario 4

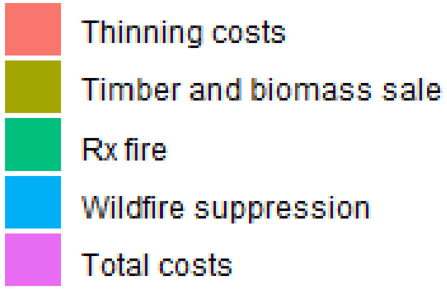
Carbon sequestration increases over time, and is dominated by in-forest carbon storage

- Most: Scenario 1 Least: Scenario 3
- Treatments reduce carbon storage despite avoiding emissions from wildfires

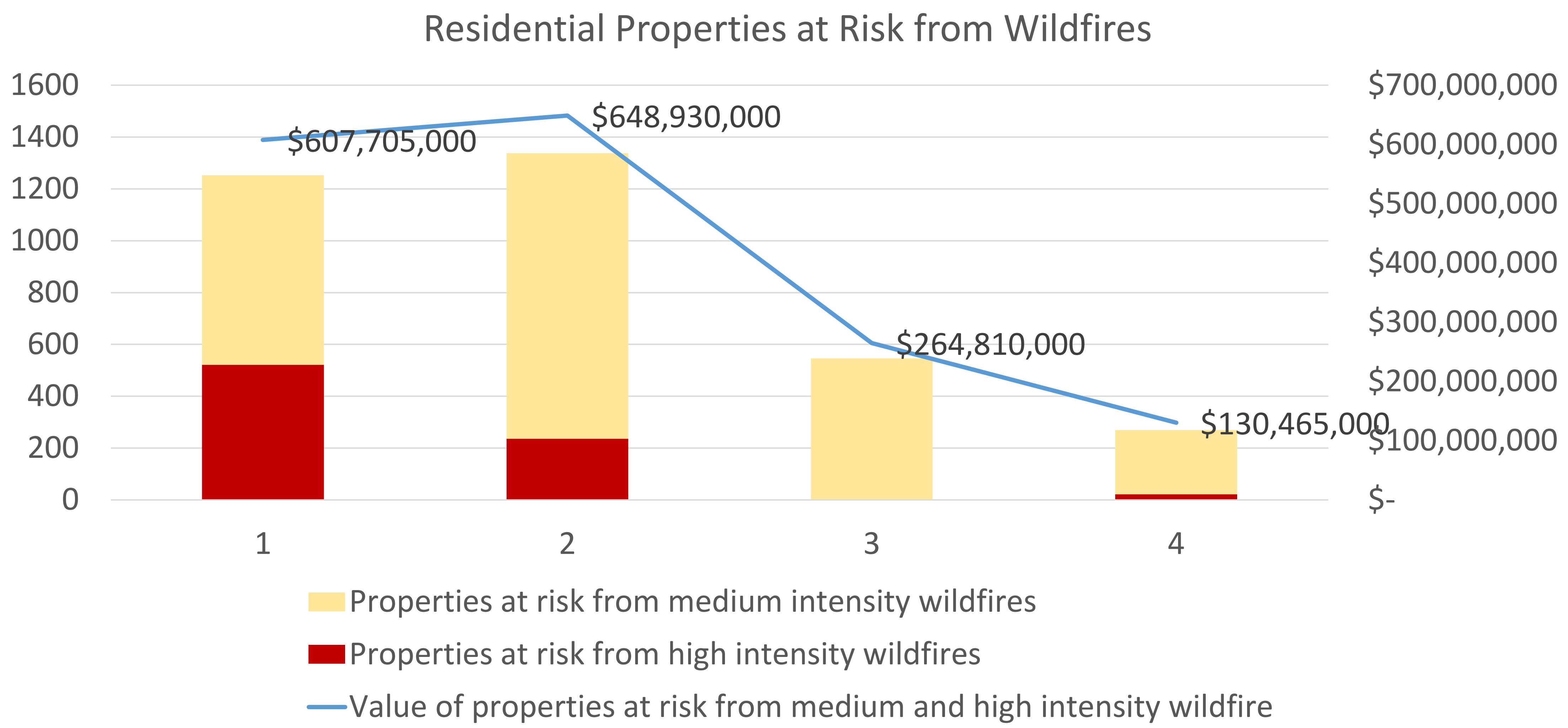


Average Annual Costs of Treatment and Suppression (2010-2040)





Property at Risk in Lake Tahoe West (2010-2040)



Economics Key Messages

Measure	Scenario relative performance
Cost of treatment	3>2~4>1
Cost of suppression	1~2~3>4
Risks of property losses	1>2>4>3
Smoke impacts from extreme wildfires	3>2~4>1
Carbon sequestration	1>4~2>3
By-products from thinning	3>2>4>1

Overall Evaluation

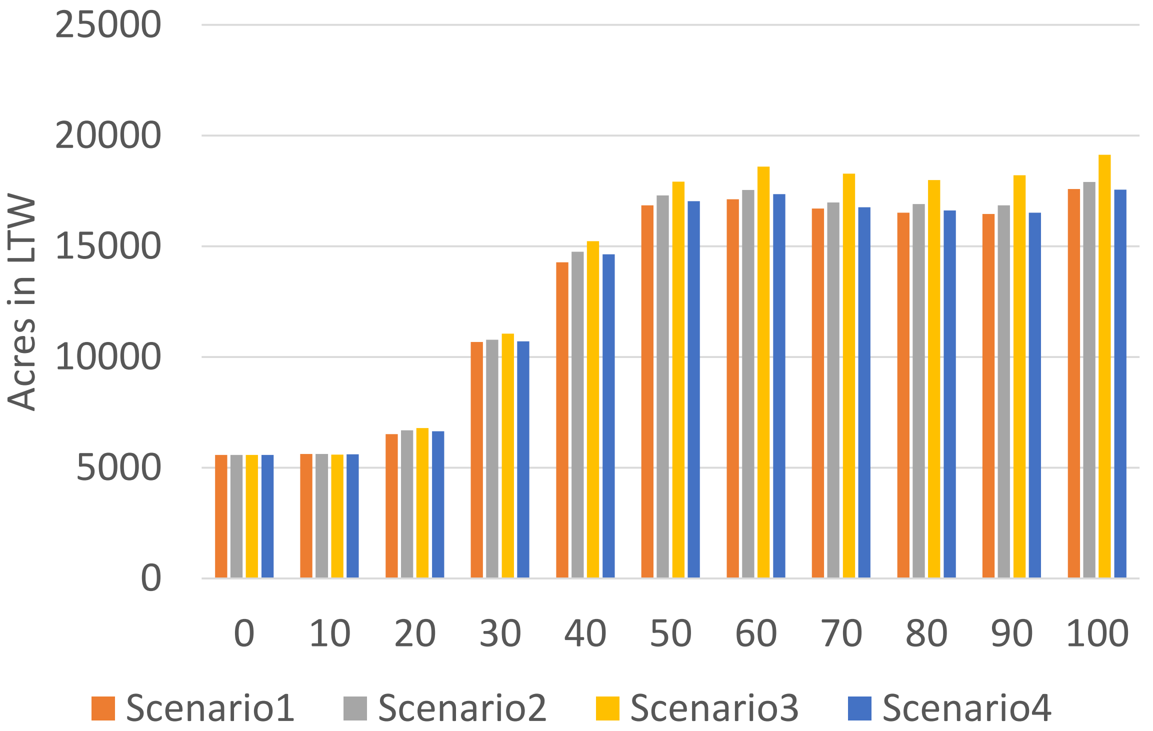
Implications, Caveats, and Next Steps

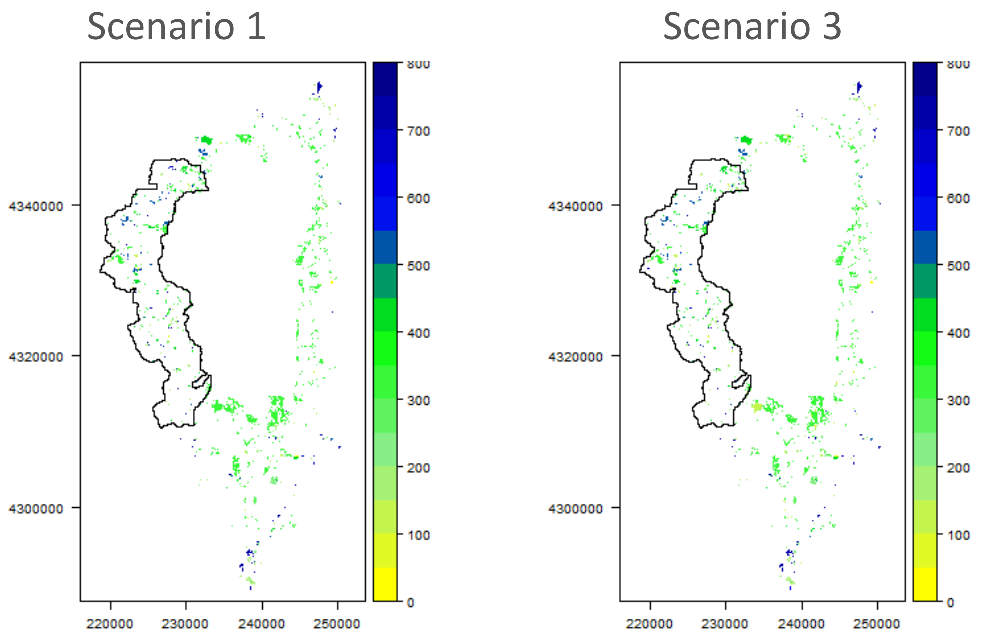
1) Treatment promotes most objectives

- Modeling suggests that more treatment (thinning and to some extent, prescribed burning) favors most resource values, except carbon sequestration and cost of treatment
- Scenarios 1 and 2 do not lower key risks from high-severity wildfires (property loss, large patches, and extreme emission days) as effectively as Scenario 3.
- These results suggest that extending treatments beyond WUI areas improved outcomes relative to treating the WUI alone

2) Large old forest increases

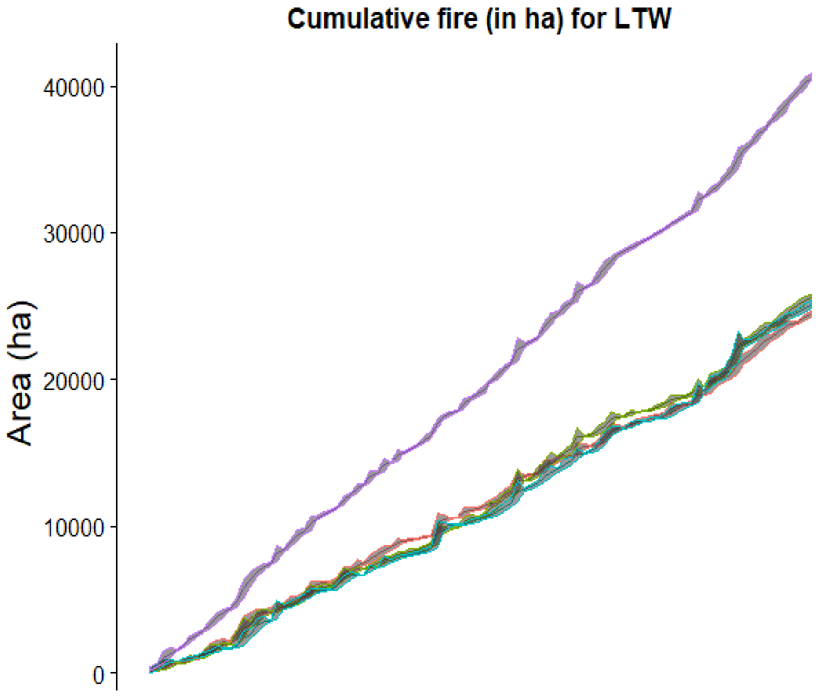
- There is considerable momentum in the system—so more carbon will be stored, areas with large trees and "late seral" vegetation will expand under all scenarios
- The values associated with old-forest are generally sustained and even enhanced with treatment

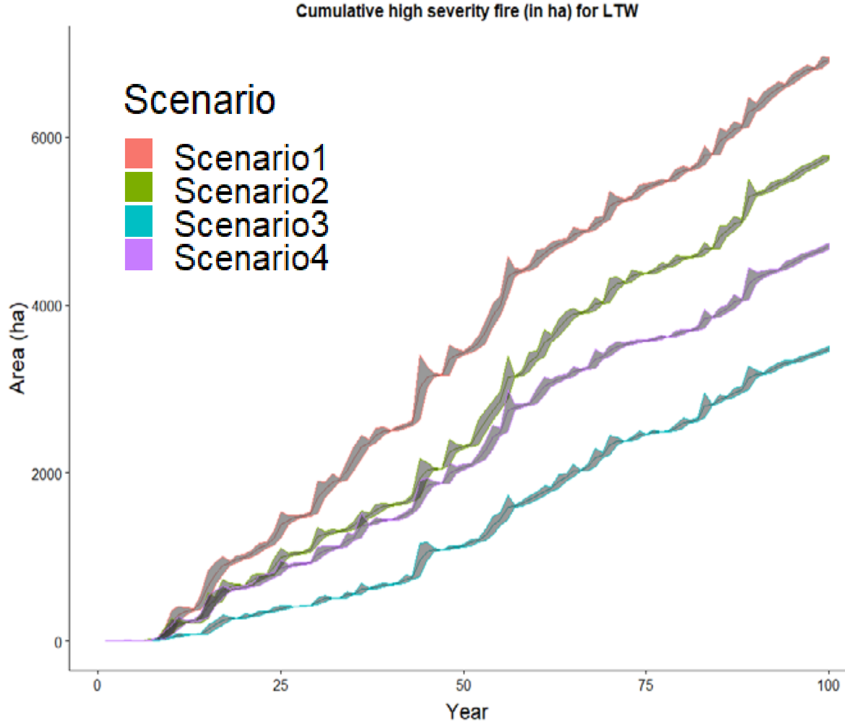




3) Expect more fire regardless of scenario, but expect less severe fire with treatment

- It is important to consider metrics that are sensitive to fire intensity (e.g., high severity patches, air quality, and water quality)
- Treatments alter fire intensity more than area burned, although Scenario 4 resulted in significantly more burning at low severity by design
- Scenario 1 results in the most high severity burned area and large patches of high severity





4) Thinning is important and low-risk

- Thinning generally pose little risk to water quality
- Short-term risks associated with increased use of roads should be considered for mitigation opportunities
- Fine-scale modeling indicates that removal of understory trees up to 20 m tall would generate water quantity benefits in many areas
- Thinning trees at least up to 30” DBH may be particularly important for restoring vegetative structure and composition in areas such as aspen stands
- Thinning understory trees appears generally consistent with promoting late seral forest, areas with old trees, biodiversity, and habitat for old-forest associates

5) Prescribed burning is important, although it may entail more risk

- Scenario 4 reduced risk to property and restored more low-severity fire, although it could increase risks to water and air quality that require careful analysis and design
- This result suggests that prescribed burning is an effective complement or substitute for thinning
- Model results may overestimate some risks (especially water quality) from landscape prescribed burning
- The models do not capture non-structural fire effects important for some wildlife species and understory plants
- There is uncertainty about how extensive and frequent prescribed burning would affect water quality and air quality, suggesting a need for further analysis *and* adaptive management

Next Steps for Landscape Modeling

- Create a preferred scenario to help evaluate the restoration strategy compared to a reference
- Refinement of results for air quality and water quality
- Reporting and publication of findings

Incorporating Key Modeling Findings in the Landscape Restoration Strategy

Lake Tahoe West

Stakeholder Science Committee Meeting

May 7, 2019

- The LRS is informed by
  - Most current and best available science
    - GTR-220; GTR-237 (Managing strategies for Sierra Nevada forests)
    - GTR-247 (Sierra Nevada Science Synthesis)
    - GTR-254: *The California Spotted Owl: Current State of Knowledge*
  - The Lake Tahoe West Landscape Resilience Assessment – 2018
  - Professional expertise of the inter-disciplinary multi-agency team of resource professionals
    - With input from and review by Science Stakeholders
    - With input from and review by the LTW Science Team
  - Lake Tahoe West specific science modeling
    - See Science Team findings presentations for full list

Incorporation of Modeling Results

- Using modeling results to understand impacts of treatments on resource values over time
  - Validation that the management actions in the LRS will result in positive outcomes over time
    - Increase in late seral habitat
    - Increase in large trees
    - Maintain/increase in species diversity
    - Water quantity benefits
    - Reduce the risk of large, high intensity burns
  - Support for **whole landscape approaches** (expanding treatments beyond the WUI) to achieve forest health and resilience objectives
    - Reduced risks to communities
    - Fewer large patches of high severity fire
    - More low/moderate severity fire

Incorporation of Modeling Results

- Identification of areas of uncertainty and concern
  - Water Quality modeling highlights highest risk soils on certain soil types (e.g., 30-70%, volcanic-derived)
    - LRS will recommend managers design treatments that avoid most sensitive soils and/or reduce risk of fire impacts to those slopes
    - Implement treatments on sensitive soils that retain adequate soil cover post treatment – possibly thinning with areal removal, limitations on prescribed fire
  - Increased use of roads for removal of restoration bi-products has short-term risks for water quality
    - LRS will recommend managers implement mitigations to reduce risks

Incorporation of Modeling Results

- Uncertainty and concern continued
  - Increase use of fire may increase risk to air and water quality and uncertainty about how extensive Rx fire impacts will be to both
    - LRS will recommend monitoring and adaptive management for Rx fire treatments
      - Size and duration of burns
      - Possibly avoiding sensitive soils types
- Beneficial treatment elements
  - Removing large trees are important for restoring vegetation structure and composition in aspen stands
  - Rx fire is an important post-thinning treatment for managing accumulation of surface litter and surface fuels
    - LRS recommends using Rx fire as a follow up treatment

Incorporation of Modeling Results

- Economics of treatments
  - Modeling results show thinning only has the highest cost of implementation
    - But has larger recovery of cost from removal of restoration bi-products, reduced risk of property lost, and reduced risk of smoke impacts
    - LRS recommends utilizing thinning treatments that remove biomass on slopes less than 30% with access and on slopes 30-50% with soils that have low risk for water quality
      - Reduce the amount of pile burning
      - Creates some cost benefits/biomass feedstock
    - LRS using lower cost treatments – Rx fire in areas of the landscape that do not need thinning as an initial treatments and in areas where resources may be sensitive to mechanical thinning treatments
      - PACs

Incorporating Adaptive Management

- Evaluate benefits and risks of taking understory burning to larger scales
- Evaluate potential risks of treatments in sensitive areas suggested by modeling
- Use monitoring and adaptive management to evaluate model predictions for key indicators and management performance

Lake Tahoe West Ecosystem Management Decision Support Tool, Decision Model Hierarchy
May 7, 2019

[*Draft Text, to be polished*.] **About the Decision Model**: The Decision Model is a component of the LTW Ecosystem Management Decision Support Tool. The Lake Tahoe West partners are using this tool to interpret and explore thousands of data points from modeling of potential management approaches on the west shore. This tool, including the numeric weightings in the diagram, supports decision making and understanding of complex data, and is not a substitute for the decision-making process.