DRAFT SUMMARY

STAKEHOLDER SCIENCE COMMITTEE MEETING

LAKE TAHOE WEST RESTORATION PARTNERSHIP

Tuesday, August 14, 10:30 am to 5:00 pm
Tahoe Regional Planning Agency, 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

The Lake Tahoe West Restoration Partnership (LTW) Stakeholder Science Committee (SSC) met on August 14, 2018, from 10:30am to 5pm at the Tahoe Regional Planning Agency (TRPA) in Stateline, Nevada. Meeting objectives were to: (1) Share revisions to Landscape Restoration Strategy framework; (2) Collect feedback on Landscape Restoration Strategy matrix, particularly the matrix structure/approach and five proposed Goals; and, (3) Share and discuss LANDIS model results. Stakeholders provided suggestions regarding the Landscape Restoration Strategy framework and goals. In the afternoon, Alec Kretchun presented results from LANDIS modeling, answered questions from Stakeholders, and received feedback on how visualization of results might be improved in the future.

Contents

Action Items

Action Items:

1. **ACTION ITEM**: Evan will follow up with Tracy Campbell about improving remote audio for future meetings at TRPA.
2. **ACTION ITEM**: Forest Schafer will send out TCSI Intended Landscape Outcomes to Stakeholders.
3. **ACTION ITEM**: Design Team will make suggested edits to LRS Framework.

Welcome, Agenda Review, and Introductions

Sarah Di Vittorio opened the meeting with introductions and welcomed Stakeholders to the August Stakeholder Science Committee Meeting.

The following describes the planned timelines for release of various modeling results, subject to change.

- End of August - Partial results for LANDIS and Air Quality modeling
- September 4 Stakeholder Meeting - Water Quality Group will present
- September 18 – Roads Workshop
- October – Wildlife Group will present results; further Air Quality modeling results (dispersion) will be available
- November – Water Quantity/Economics Group will present results
- EMDS Frameworks – Ongoing discussions each month, with final EMDS tool ready in December

Whenever feasible, modeling results will be presented during regular Stakeholder meetings. We may need to schedule some meetings outside the regular meeting schedule to fit it all in.

Ms. Di Vittorio reviewed the meeting agenda and began with an introduction of the existing Landscape Restoration Strategy (LRS) documentation, below.

1. Landscape Restoration Strategy Framework, Part A

The first half of the meeting was dedicated to review and discussion of the *LRS Matrix* (a new document) and the *LRS Framework* (a revised document from the previous Stakeholder meeting).

Based on Stakeholder feedback from the July meeting, some updates that were made to the *LRS Framework* document include, but are not limited to:

- Revised, "Goals".
- Added "Objectives" category (intermedaite steps to get us to a goal).
- Changed the name, "Design Rules," to, "Actions & Prioritization Guidelines." These identify how to treat, how much, and generally where (without identifying specific project sites).
- Changed the name, "Resource Protection Measures," to, "Project-level Implementation Guidance."
- Revised, "Principles."
- Revised, "Required Components."
- Added, "Decision-Making Criteria," category (designed to help develop consensus and make tradeoffs - EMDS will also help make tradeoffs).

The *LRS Matrix* will serve as the "meat" of the strategy by specifying how to treat the landscape to achieve resilience. "Objectives," and, "Actions & Prioritization Guidelines," are not fully developed and serve as placeholder examples – they were included in this draft to communicate the conepts behind each column."Project-Level Implementation Guidance," is also a placeholder, and would provide sideboards for project-specific implementation of actions that may be controversial (ex. where/how to treat PACs).

Discussion followed:

- Q: Is a "matrix" the best structure to convey the purpose of the *LRS Matrix* document?

    - There is value in matrix structure - it helps envision what the LRS may look like and helps the Design Team to plan. However, there may not be a direct correspondence between columns (ex. "Objective A" may not relevant only to column next to it). For some goals, there will be actions that hit multiple goals (ex. Fire on the ground achieves multiple goals).
    - Suggestion: Display Objectives as blocks not rows.
    - Suggestion: This is a good tool for developing the goals/objectives/actions; we can always present it in a different form in the final LRS.
- Suggestion: Add a timeline piece into objectives – it needs to also say, "When."
- Suggestion: Explicitly call out adaptive management as a piece of the Strategy.
    - The LRS is envisioned as a document that is specific for project planning, but with enough room for adaptive management.
    - Currently there is a statement about adaptive management in Required Components. Instead, include a statement in Principles.
- There are different types of adaptive management:
    - Planned adaptive management: treat in different ways, observe and make adjustments.
    - Reactive adaptive management: adjust to changes (disturbances) in a system given a specific treatment.
- Suggestion: Frame objectives in a tighter time frame.
    - E.g., the Dinkey Strategy lays out year-by-year treatments.
- Q: What are the Design Teams' thoughts on a timeline?
    - The Design Team would like the LRS to be more specific for near term, and more flexible in the long term (modeling results will decrease in accuracy over time). Ideally the LRS would be a long term document, but realistically it may have about a 10-20 year horizon due to uncertainty in future conditions.
    - In addition, some processes may be on different timescales from one another (ex. Fire).
    - Suggestion: A 10-year plan may be most digestible.
    - Collaboration in the Lake Tahoe Basin will continue. The LRS should be revisited in 10 years anyway – the timeline could be more about setting up future collaboration.
- Suggestion: The LRS should consider when retreatment will be needed - people will want to know how long treatments last.
    - Suggestion: Instead of tying directly to a specific time for retreatment, tie to the monitoring plan and observed conditions, and initial prioritization guidelines (when "X," do "Y").
- Q: Would the LRS timeframe influence the scope of work in environmental analysis?
    - The LRS is more of a vision document, and should not be confined to just projects being analyzed.
- Suggestion: Call out actions necessary in a specific timeframe to achieve Goals while recognizing that actions may no longer be appropriate "X" amount of years into the future.
    - Treat to achieve specific Goals but don't be too prescriptive.
- If priorities change, information about treatment results may not have as much influence on adaptive management.
- Suggestion: Concrete, specific information should be in Actions & Prioritization Guidelines (ex. # of acres to treat). This will help to achieve a narrative consistency in the Objectives.
- Suggestion: Be careful calling out specific actions that may not be realistic (ex. "prevent spread of invasive species," when we can only monitor for and implement management tactics). Do not over-promise.

    - Suggestion: “Take preventative measures to…”

Jen Greenberg presented adjustments that were made to the, “Goals” of the *LRS Framework,* following feedback from the July 11 Stakeholder Science Committee Meeting. “Goals,” were developed by building on the Tahoe Central Sierra Initiative’s (TCSI’s) Desired Landscape Outcomes, which were loosely based on the LTW Landscape Resilience Assessment (LRA) indicators (Landscape Values and Services). The Design Team requested feedback on content and wording.

Stakeholders provided feedback to the 5 different revised, “Goals,” described, below:

1. *Increase forest heterogeneity through structural and seral stage diversity to promote wildlife habitat. Diversity of seral stages is restored across the landscape with structure and composition according to best available science characterizing resilient forests. Forest structure is such that fire can burn in an ecologically beneficial way that perpetuates landscape heterogeneity. Forests remain sustainable, long-term carbon sinks. Soil structure and function are maintained.*

- TCSI combined. #1 and #2 to convey interaction among species. The framing of these two goals could be tweaked to help approach specifics with respect to species interactions and networks. Objectives could then be nested under that.

2. *The diverse and interacting network of native terrestrial vegetation species and ecological communities is present across the landscape to support and sustain their full suite of ecological and cultural roles and to enhance plant and wildlife diversity. Properly functioning and healthy meadow and riparian habitat exists across the landscape. Prevent, remediate, and control invasions of exotic species.*

- Remove “terrestrial vegetation.”

3. *Maintain or improve water quality and hydrologic connectivity for meadow and riparian functions. Water reliability, quantity, quality, and connectivity are buffered against precipitation variability and disturbance. Native aquatic species are well distributed throughout their historic range, and connectivity provides unobstructed movement sufficient to meet life history requirements. Prevent, remediate, and control invasions of exotic species.*

- Change, “historic range,” to, “enough to meet life history requirements.”

4. *Recreational, residential, and tribal cultural communities are integrated into restoration efforts. Recreation opportunities are promoted while removing stress from neighborhoods and ecologically sensitive areas. Society lives safely with wildfire, and is accepting of both the natural ecological dynamics and management for restoration and hazard reduction. When fire burns, it rarely threatens human safety or infrastructure and smoke impacts are minimized.*

- Suggestion: Treatments in WUI could fall more under Goal #4, while treatments in the General Forest could fall more under Goals #1 and #2.
- Change, “from neighborhoods,” to, “to neighborhoods.”
- Suggestion: The last sentence doesn’t go far enough – it is too lean, and could be a goal in itself.
    - Highlight that fire is a process, not just a treatment.

    - Be explicit about fire and its role in human/ecological communities.
    - It could be more of an, “Objective,” and/or an action-level statement.
- Q: Should there be greater emphasis surrounding fire?
    - People will want to know if we are doing more thinning and prescribed fire. There are plenty of pre-planning actions (fire lines, public education, etc.) that could fit into this. Planning in advance to put more fire on the ground would help improve the process and outcomes.

5. *Working across jurisdictions and the treatment of multiple resources in the same entry increases project efficiency. Forest products are harvested sustainably and utilized at their highest and best use, promoting community workforce development and sustainable capacity for restoration activities. Economies benefit from local employment opportunities and training for restoration planning, design, implementation, or monitoring benefit economies.*

- Q: Should there be a separate, “Goal,” for Economics?
- Suggestion: Name goals for their purpose/themes (ex. wildlife, community, etc.)

2. Landscape Restoration Strategy Framework, Part B

Jason Vasques proposed a structure for the *LRS Matrix* using an example from marine protected area planning efforts and containing four main elements:.”

Vision	Goals	Objective	Action
Narrative description of a resilient Landscape	**What we want to achieve and why**	**A specified end, condition, or state that is a measurable intermediate step toward achieving a goal**	**The specific action you would take to achieve the Objective**
e.g., A healthy coral reef, as characterized by….	e.g., (1) Shift markets to support sustainable fishing. (2) Limit access to the fishery to remove pressure	e.g., (relative to goal 2) Impose restrictions on boats in X location	e.g., a. Help boats change gear, b. Create public outreach campaign to reach X people

Discussion followed:

- Suggested Goal statement - thin forest and apply prescribed fire to alter fire behavior and improve the resilience of the forest.
    - Goals should be broader. The ways to get there (thinning, prescribed fire, etc.) are in the Objectives, while the tools to do so are the Action.
    - Broader statements will also give goal statements a longer lifespan.
- Suggested Goal statement - greater forest heterogeneity.
    - Objective would be certain ratios of seral classes. Action would be how to get there.
- We should have multiple vision statements.

        - One could encompass Goals 1-3, one for Goals 4-5.
    - Goals and Actions are most important to presenting to public – be mindful when developing structure.
    - Wildlife is missing from Goals.
    - Suggestion: Treat as plants & animals, and terrestrial & aquatic.
            - Aquatic and terrestrial were separated in 2 and 3 because different actions are involved in reaching goal
    - Why the focus on habitat, but not wildlife itself?
        - Response: LTW is not doing actions directly on wildlife. Our actions will be toward habitat improvement.
        - Treatments will create habitat – but won't necessary bring wildlife back.
        - Have called out enhance "plant and wildlife diversity"
            - Stakeholder feedback: Not enough, needs to encompass interactions and relations of communities.
- Instead of repeating Actions for different Goals, have Actions be numbered and refer to them - it could be more of a diagram. One action will apply to multiple Goals.
- Project-level Implementation Guidance can appear in a separate table.
- Suggestion: Goal #1 is too much detail– some of it could move to Objectives.
- Suggestion: Make goals short statements with plain language – simplify.
    - Objectives will flesh out Goals
- Suggestion: Describe "states," not, "actions," in Goals.
- Q: Is there an example of Vision, Goals, and Objectives relative to Forest Health?
    - The Forest Plan may provide a good example.
    - **ACTION ITEM**: Forest Schafer will send out TCSI ILOs to Stakeholders.
- Suggestion: Think about how the graphic in the "Restoration Strategy Goals" document and how that could be used moving forward.

3. LANDIS Results: Scenarios 1 - 4

Alec Kretchun presented LANDIS results from Scenarios 1-4. The purpose of the presentation was to review how the scenarios were developed and run, present preliminary results to show potential use of data, answer questions, and discuss next steps.

LANDIS stands for, "Landscape Disturbance and Succession," and is an open source, spatially dynamic and spatially explicit model that works at a landscape scale (10,000 to 10 million acres). Aspatial processes happen within each cell, while climate change occurs across all cells. There are many extensions to the program, though the "Harvest extension" is primary tool for modeling LTW scenarios.

The landscape is divided by management areas and stands based on slope and vegetation characteristics. Annual treatment targets are set by multiplying prescription type by the management area. Stands are randomly selected for treatment, and once treated it assumes that the biomass is removed and it effectively disappears from the model. Trees are organized in species/age cohorts - LANDIS is not an individual tree model.

A new Fire Extension was developed for LANDIS to perform the modeling, using three distinct ignition types: lightning, human accidental, and prescribed fire. Ignition probabilities are assigned spatially through cells based on historic ignitions and modeling. Probabilities of ignition types are influenced by climate, and fire sizes are emergent from fire weather, available fuel load, and topography. Species-specific mortality is a function of fire intensity, which is categorized into three main levels: under 4ft, 4 to 8ft, and greater than 8 ft flame lengths. Particulate Matter (PM5, PM2.5, etc.) and Greenhouse Gas (GHG) emissions are direct outputs. Suppression levels are explicitly modeling through delineated zones: low, medium, and high. Suppression levels are incorporated into the model by limiting fire spread. Fire weather also influences fire spread, and can override any suppression if conditions are bad enough. A fire will spread until limited by either suppression or fire weather.

Four treatment scenarios were tested. Scenario 1 (S1) was defined as the "no treatment" scenario, which provided a baseline where only suppression occurred. In Scenario 2 (S2), the Business as Usual (BAU) scenario, treatments were based on current priorities and amounts Scenario 3 (S3) tested increased levels of treatment where the primary method was Mechanical and Hand Thinning. Finally, Scenario 4 (S4) tested increased levels of treatment with Prescribed Fire as the primary tool.

Scenarios were run for 100 years under annual time steps – 10 replicates were run for each Scenario (5 shown in this presentation). Scenarios will be run under two climate conditions: low emissions climate, and high emissions climate. Results from low emissions climate conditions (RCP4.5, 2 degrees warming by 2100) were presented today.

Targets for harvest were developed for the Lake Tahoe West landscape and expanded to the entire Basin. The model was assigned to achieve a target through random selection of stands – treatment amounts do not fluctuate significantly year to year.

Alec presented results graphics, with Stakeholder questions detailed, below:

Harvest

Harvest

IADT scenario design – Lake Tahoe West

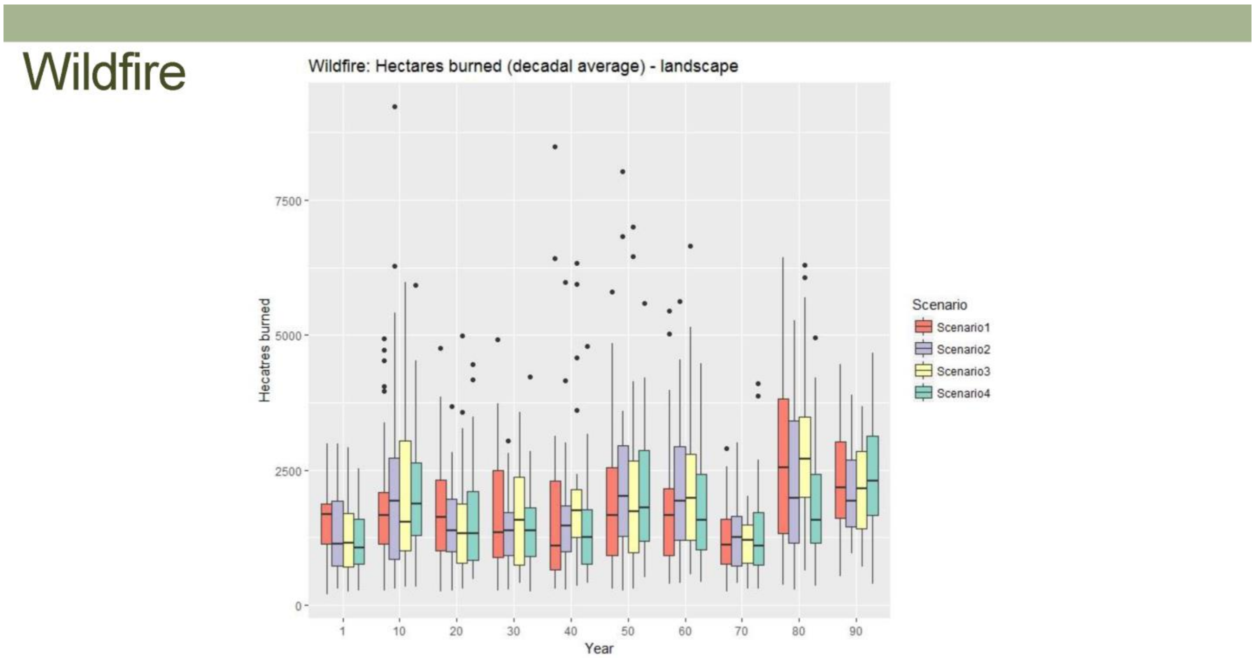
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Hectares treated (mechanical/hand)	0	404	1618	303

LANDIS-II results – entire landscape

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Hectares treated (mechanical/hand)	0	1620±52	5971.7±63	1230±63
Mean biomass removed	0	48.5 tonnes/ha	34.9 tonnes/ha	42.5 tonnes/ha

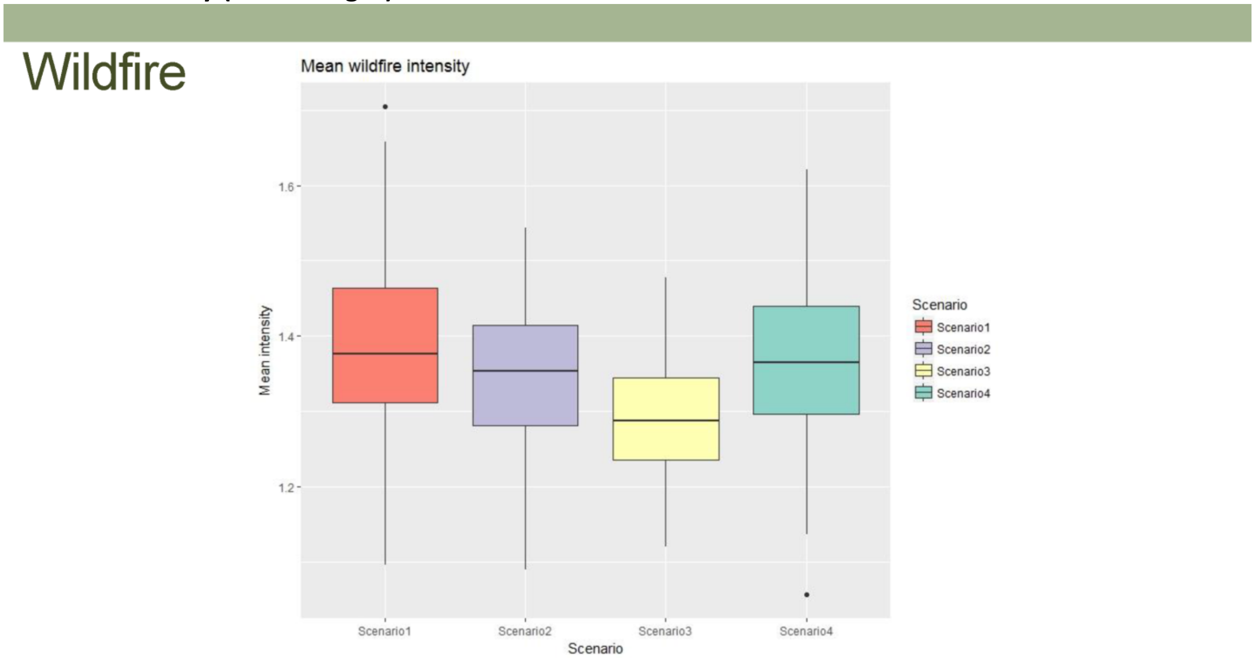
- Q: Why is the average biomass in S3 less than S2 and S4?
  - Total amount of biomass removed is far greater in S3, but treatments included more hand thinning (no biomass), which drives the average down.
- Q: Does the biomass figure include both live and dead?
  - Only live - all biomass is assumed to be removed from the site – LANDIS can't model piles that will be left on landscape.
  - Moving forward, the modeling team will be working more on fleshing out differences between piles and mechanically removed biomass.
- Q: Is LANDIS modeling for the entire Basin?
  - Yes, not just LTW landscape.
  - (There was discussion about how this may influence results for the LTW landscape, which the Design Team and Science Team will want to consider moving forward.)

Wildfire acres burned



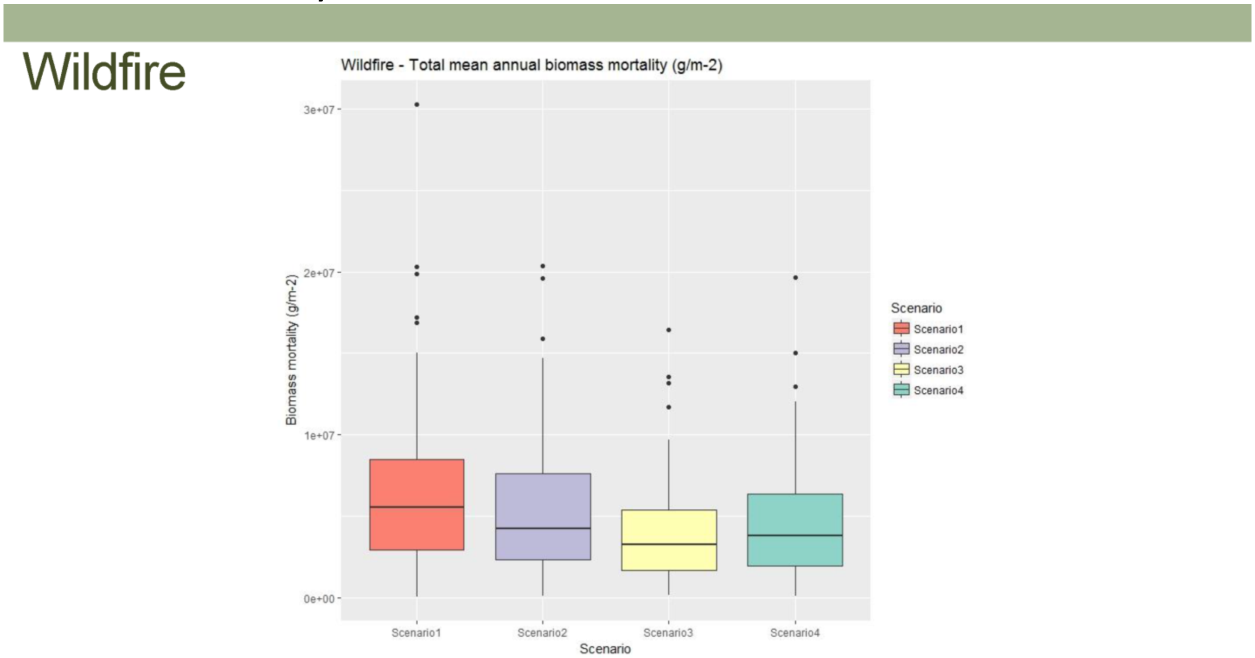
- There appears to be no consistent pattern in reduction in hectares burned by Scenario.
- Q: What is happening in decade 7? It appears to be an anomaly.
    - Only using one Global Climate Model (GCM) – it could be a result of a quirk in that.

Wildfire intensity (flame length)



- Mean intensity is a 0 to 3 scale based on flame length categories.
- The graph collapses all decades into one figure.
- Another analysis will look at occurrence of high-intensity patches.
- Q: How is mean intensity linked to flame length? What is the intensity?
    - 1 = <4ft; 2 = 4 to 8 ft; 3 = >8 ft
- Q: What do the boxes and whiskers represent?
    - Whiskers are quartiles.
- Q: Are the differences significant?
    - They do not look large, but the summarization inherent in the graph may downplay the actual significance of the difference.
- Q: Can classes by scaled? There may be a problem with averaging binned up classes.
    - The figure represents average fire class, and does not directly translate to flame length.
    - Suggestion: Separate scenarios into the three bins – have a histogram of occurrence.

Wildfire biomass mortality



- Total mean annual biomass mortality (g/m^2) was significantly lower in S3 than in S1.
- Q: What is the scale of the y-axis?
    - The difference between S1 and S3 is about 1 million tons across the landscape.
    - To convert from g/m^2 to tons/hectare, divide by 100.
    - Suggestion: Scales need help translating.

Wildfire – Prescribed fires

Wildfire – Prescribed fires

IADT scenario 4 design
Total prescribed fire/yr: 1321 ha

LANDIS-II results – entire landscape

Mean total annual prescribed fire (ha)	1256.6ha
Mean prescribed fire size	41.8ha ± 2
Earliest recorded fire	Sept-16*
Latest recorded fire	Nov-1**
Mean number of fires/yr	30

Photo courtesy of Carl Skinner

*constrained in model
**emergent from fire weather/burn window

- Figures pertain more to broadcast burning and do not include pile burning.
- Burn windows are dictated by fire weather – it may not be realistic to burn this much in a given time window, but the aim was to observe potential effects.
- Q: Can we look at outputs specific to West Shore?
    - Yes, but results being presented today are for the whole Basin.
- Q: Could treatments being done outside of LTW influence results of LTW landscape?
    - Yes, possibly; though modeling the entire Basin was a contingency of the funding.
    - Suggestion: We need to make sure results are not dependent on outside treatments, or to identify the amount of dependence.
- Suggestion: Have Alec do sensitivity testing to observe what fires are happening in the boundary zones and how large/frequent the fires are.
    - Want to buffer landscape and look at the pure effects of the treatment approaches on the LTW landscape.
    - Could be something that fits in more when designing treatments in boundary areas.

Insect morality

Insect mortality

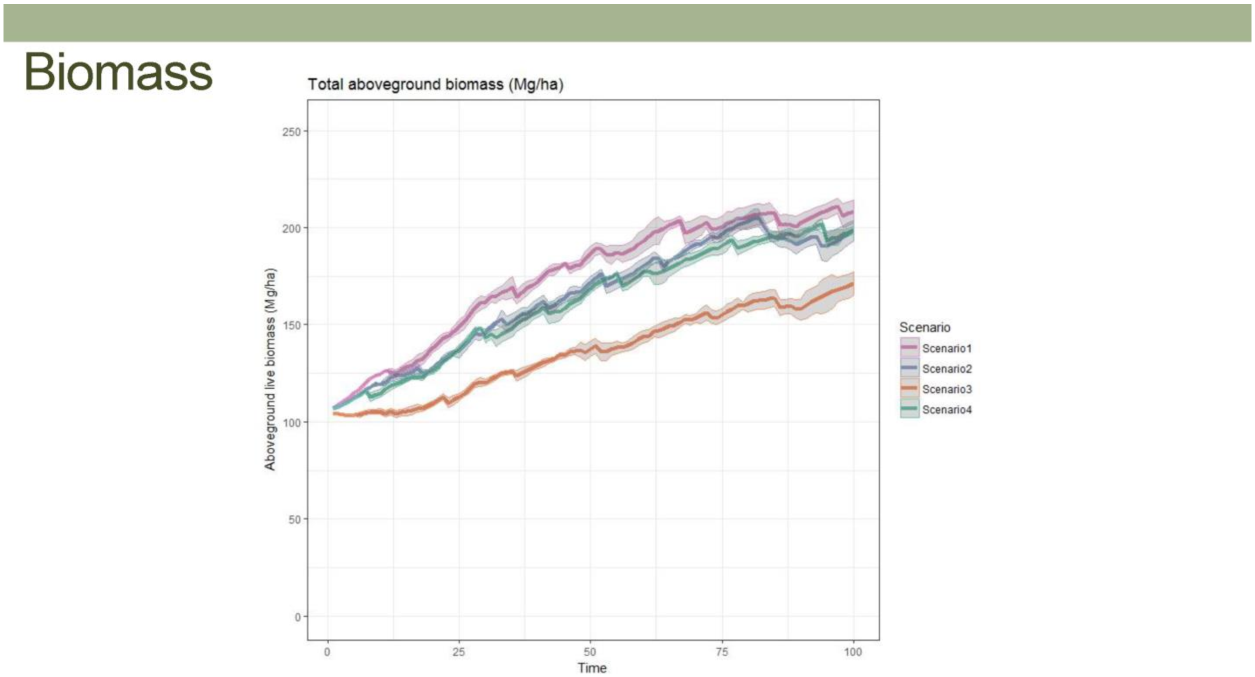
Bark beetle modeling
- 3 separate species: Jeffrey Pine Beetle, Mountain Pine Beetle, Fir Engraver
- Hosts are species (beetle/tree) and age specific
- Outbreak severity and total outbreak size are a product of host availability

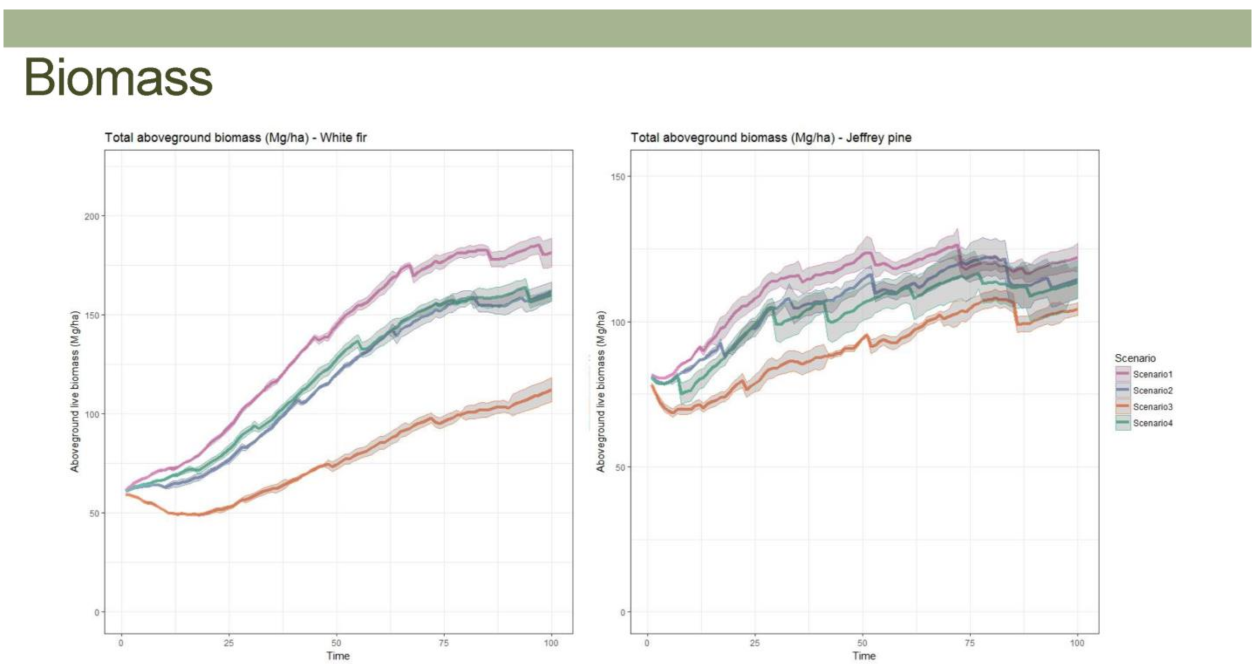
LANDIS-II results – entire landscape

Scenario	Mean number of damaged sites (outbreak year)	Mean mortality in damaged sites
Scenario 1	1409ha	26244 (83765) g/m-2
Scenario 2	1298ha	21380 (75687) g/m-2
Scenario 3	1250ha	17290 (60140) g/m-2
Scenario 4	1321ha	18796 (63311) g/m-2

- Host susceptibility is dependent on trees species and age class.
- Outbreak severity and total outbreak size is a product of host availability.
- Mean number of damaged sites: S1 is largest, followed by S4, S2, and S3.
- Mean mortality in damaged sizes and maximum values (in parentheses) are highest in S1 and S2, and lowest in S3 and S4.
- Need more context to understand these results- What is the context? What are background mortality levels? What is the baseline? What is the mortality in (tree species, age class, etc.)? What is the spatial continuity/patchiness of the mortality?
- Suggestion: Use acres, number of trees, or percentage as a measure.
- Suggestion: Look at patterns over time. Many factors go into outbreak years (drought, climate, biology) - it would help to identify what management actions are influencing and what they are not.
- Use of climate projections makes establishing a baseline difficult.
    - The baseline could be a goal of what is wanted on the landscape.

Biomass

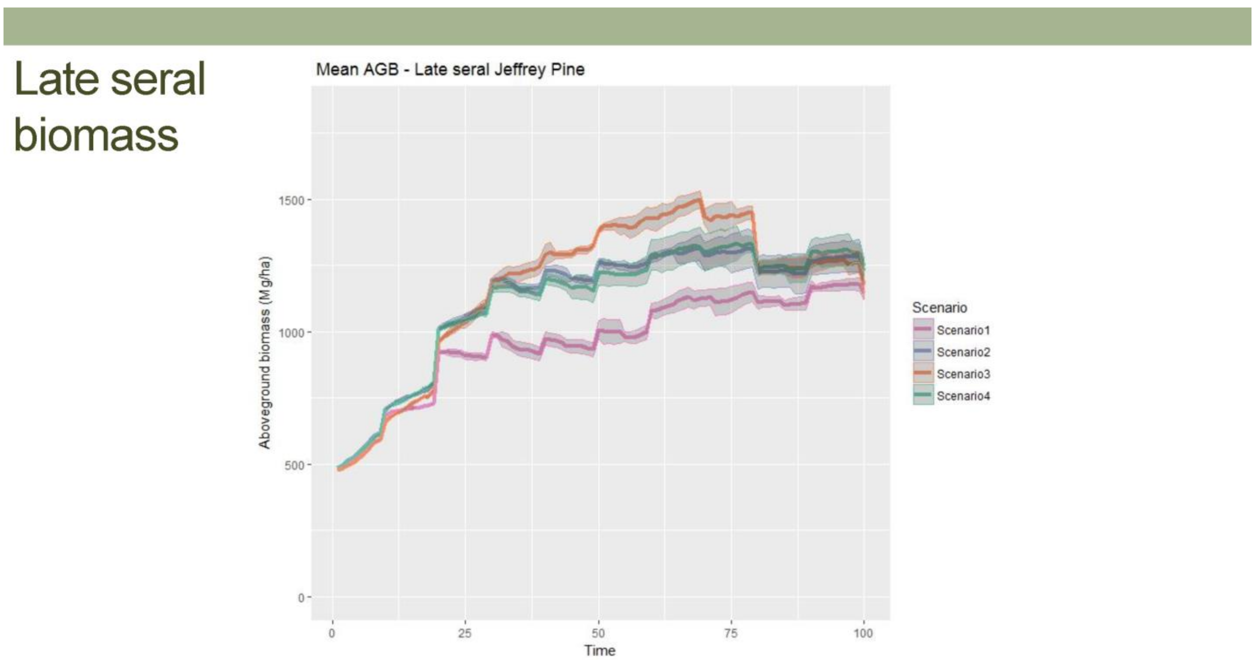




- Graphs show reductions of aboveground biomass for all treatments.
- Increasing trend in all due to recovery from clear-cutting
- S2 and S4 catch up to S1 in later years – one theory is that this represents a "payoff" of treatment (increased growth of older trees).
- Q: What is the appropriate amount of biomass for the landscape to hold – what is the carrying capacity?
    - Not yet known – it will have to be determined based on multiple factors.

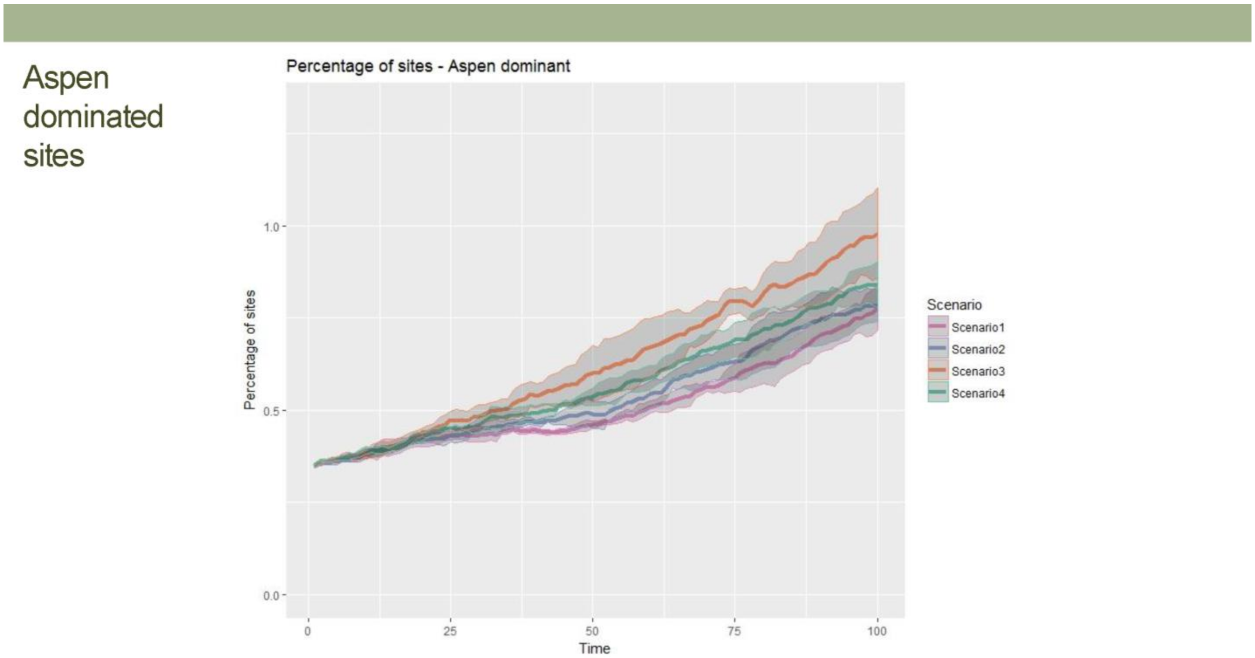
- Q: Is "live biomass" just trees or also shrubs?
  - "Live biomass" includes shrubs.
  - Suggestion: Shrubs might be popping up where fires have been – it might be helpful to separate out shrubs, then breakout component parts of trees (species, size classes).
    - There is a need to have more context with other pools (what is being removed, what is lost to fire, etc.).
- Q: Why does S3 have lower biomass in year 0?
  - Alec will explore.
- Suggestion: Put highest priority outcomes first – biomass may not be the highest priority.
- Q: Is biomass increase from small trees or large trees?
  - The fact that biomass trends continue to increase is potentially bad - need to know the breakdown of small vs. large.

Late seral biomass



- Biomass in late seral (Jeffery Pine) – highest in S3
- Q: Why are scenarios for similar for first 25 years?
  - Likely due two main factors - general landscape growth and treatments take time to affect the landscape.

Aspen dominated stands



- Aspen dominated sites highest in S3, then S4, then S2, then S1.

Next Steps

- Consider different ways to represent LANDIS results. Rolling up the results in these broad summaries makes it hard to tell what is going on.
    - Want to see breakdown of results by region (LTW, East side vs. West side).
    - More clarity with fire severity, patch size.
    - Could map (spatially) some of the results.
- Potential item of discussion for 8/16 Design Team meeting: given all the results, what do we need for Scenario 5? What do we need to justify?
    - How we choose to move forward will depend on more than just LANDIS results (other modeling results will be needed first).
- **ACTION ITEM**: Evan to follow up with Tracy about speaker pods for conference line.

Meeting Attendees

Organizing and Participating Agencies
CSP – California State Parks
CTC – California Tahoe Conservancy
NFF – National Forest Foundation
TFFT – Tahoe Fire and Fuels Team
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
USFS PNW - U.S. Forest Service Pacific Northwest Research Station

Stakeholder Science Committee Members

1. Jennifer Quashnick
2. Sue Britting
3. Roland Shaw (at 11am)
4. Matt Freitas

Staff

5. Silver Hartman, CSP
6. Sveltana Yegorova, CSP
7. Whitney Brennan, CTC
8. Jen Greenberg, CTC
9. Jason Vasques, CTC (at 11am)
10. Evan Ritzinger, NFF
11. Sarah Di Vittorio, NFF
12. Forest Schafer, TFFT
13. Nadia Tase, TFFT
14. Christina Restaino, TRPA
15. Brian Garrett, USFS LTBMU
16. Stephanie Coppeto, USFS LTBMU (at 11am)
17. Keith Reynolds, USFS PSW
18. Mike Vollmer, NTFPD

Landscape modeling preliminary results and discussion

Lake Tahoe West Stakeholders Meeting

August 14, 2018

Alec Kretchun

Research Staff, Portland State University

Dr Robert Scheller

Professor, North Carolina State University

Overview

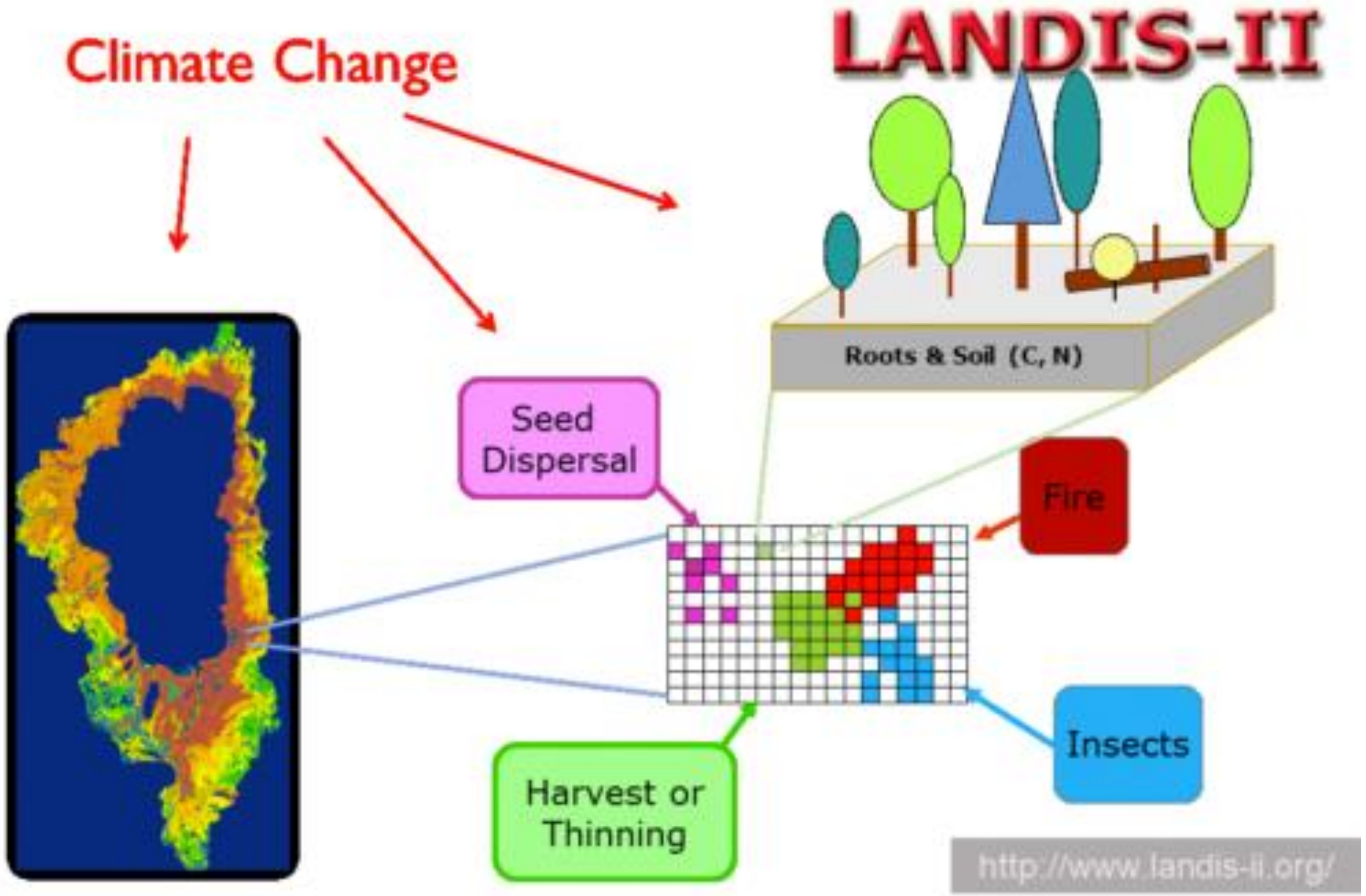
- LANDIS-II: Approach and methods
- Scenario design
- Preliminary indicator results
- Discussion
- Next steps

Goals

- Review LANDIS-II functionality
- Review scenario design
- Present examples of preliminary indicator results
- Discuss points of interest/updates

LANDIS-II

- Spatially explicit
- Spatially dynamic
- ‘Extensions’ model variety of ecosystem processes
- Landscape-scale (10k-10 million ha)
- Open source
- Used throughout Sierra Nevadas and previously in Lake Tahoe Basin



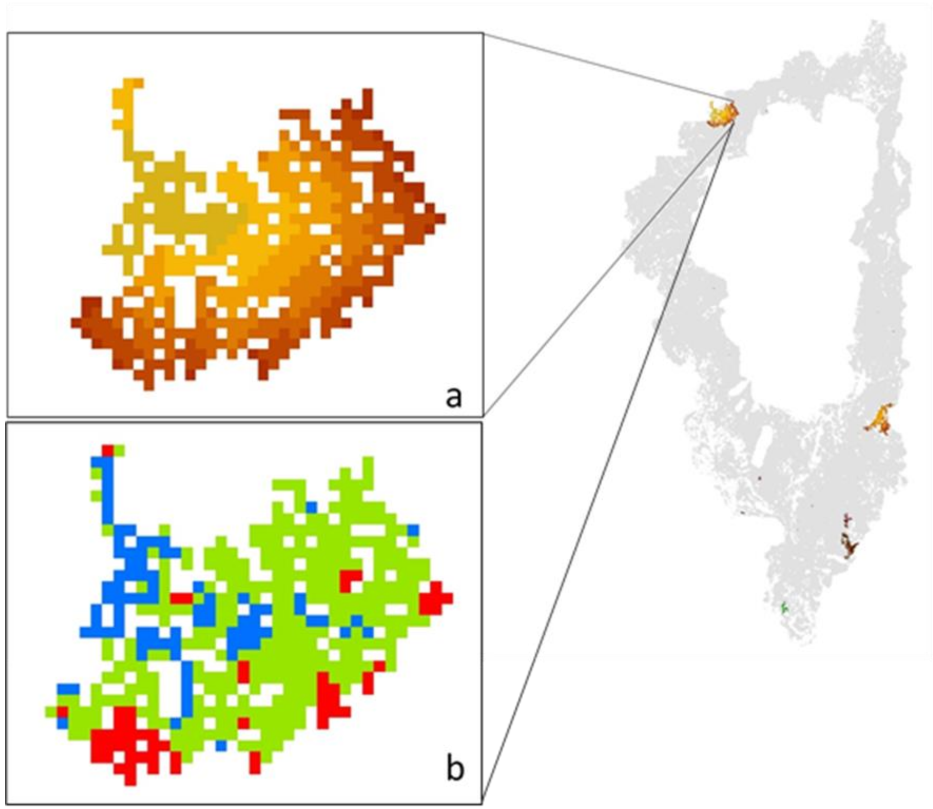
LANDIS-II: Harvest

- Landscape is divided into ‘stands’ and ‘management areas’ based on slope/veg
- Annual treatment targets are set by prescription type x management area
- Stands are randomly selected to reach treatment targets
- Prescriptions remove biomass of targeted species-age ranges
- Some harvested biomass retained on-site, most removed from site

Photo courtesy of UC Davis ANR

LANDIS-II: Fire

- Distinct ignition types: lightning, human accidental, prescribed
- Ignitions and probability of spread are climate responsive
- Fire sizes are emergent from fire weather, fine fuels, and topography (i.e. not limited to historical distributions)
- Species-specific mortality is a function of fire intensity (flame length)
- PM and GHG emissions are direct outputs
- Suppression is explicitly modeled



Daily spread (a) and
fire intensity (b) in LANDIS-II

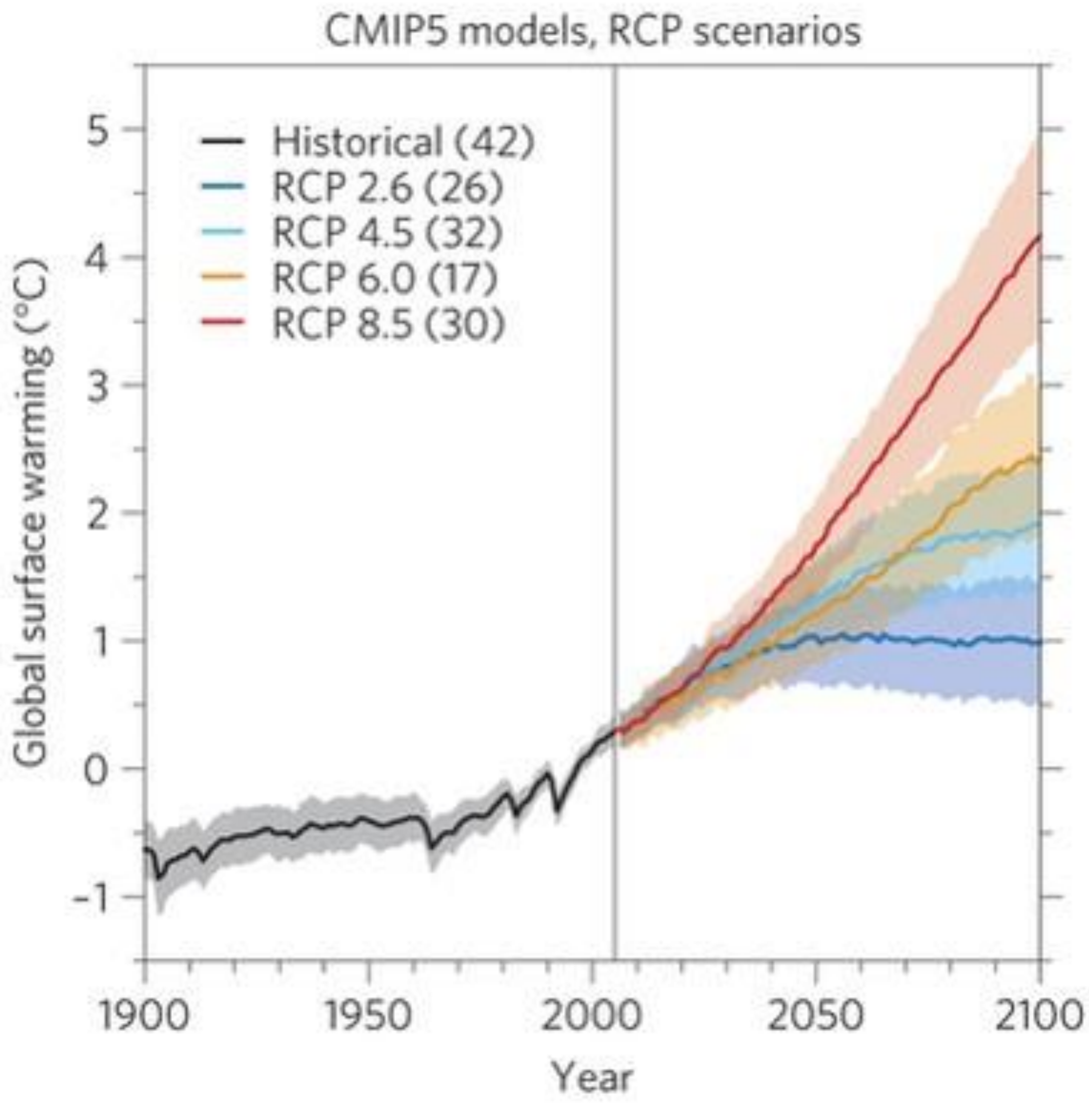
Scenario design

- Scenario 1 – No Treatment
- Scenario 2 – Community protection focused (Business as usual)
- Scenario 3 – Mechanical treatment focused
- Scenario 4 – Fire focused

Scenario design

<u>Modeling specifics</u>

- 100 year scenarios
- Annual time step
- 10 replicates of each scenario (5 shown today)
- ‘Low emissions’ climate: RCP4.5



Harvest

IADT scenario design – Lake Tahoe West

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LANDIS-II results – entire landscape

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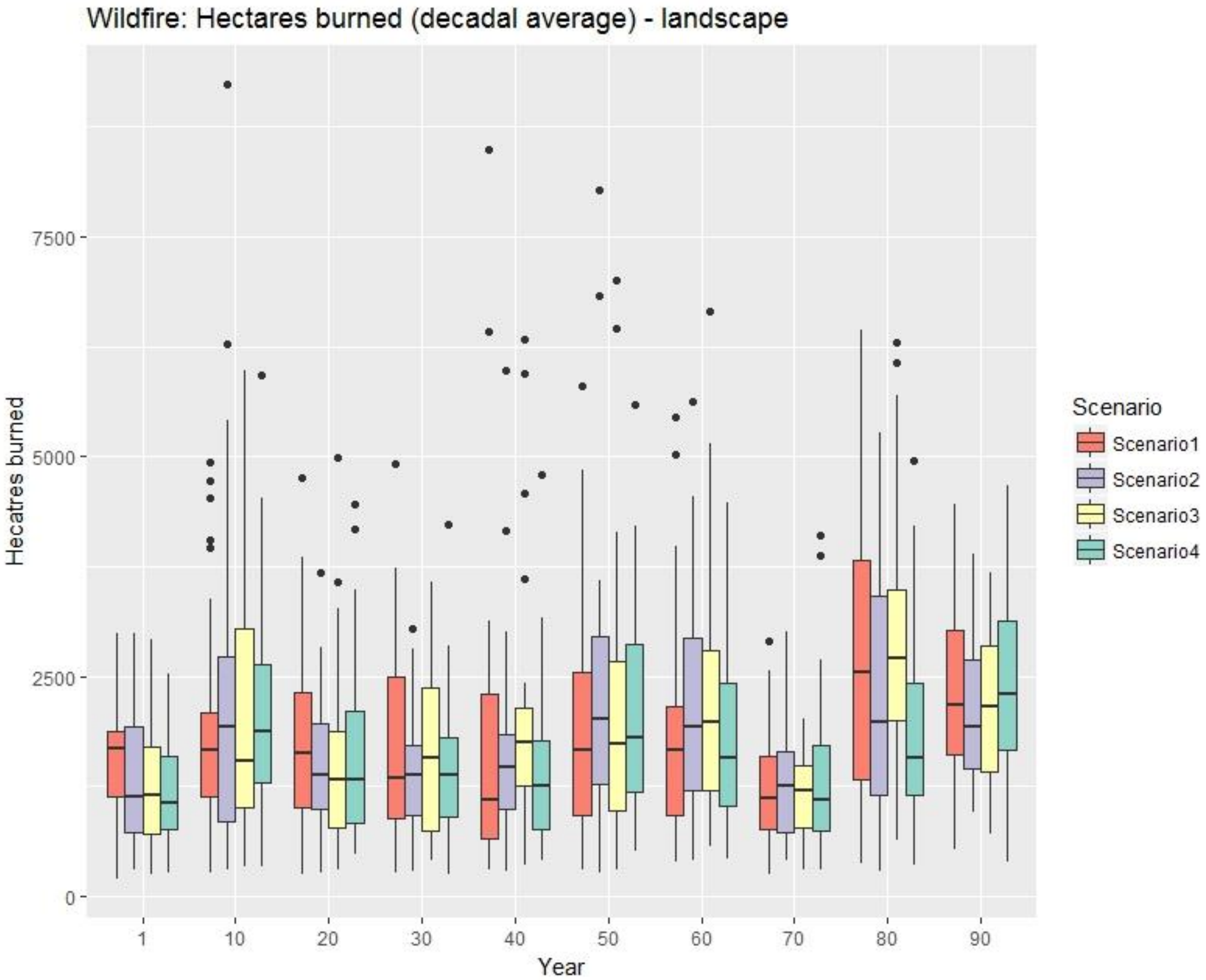
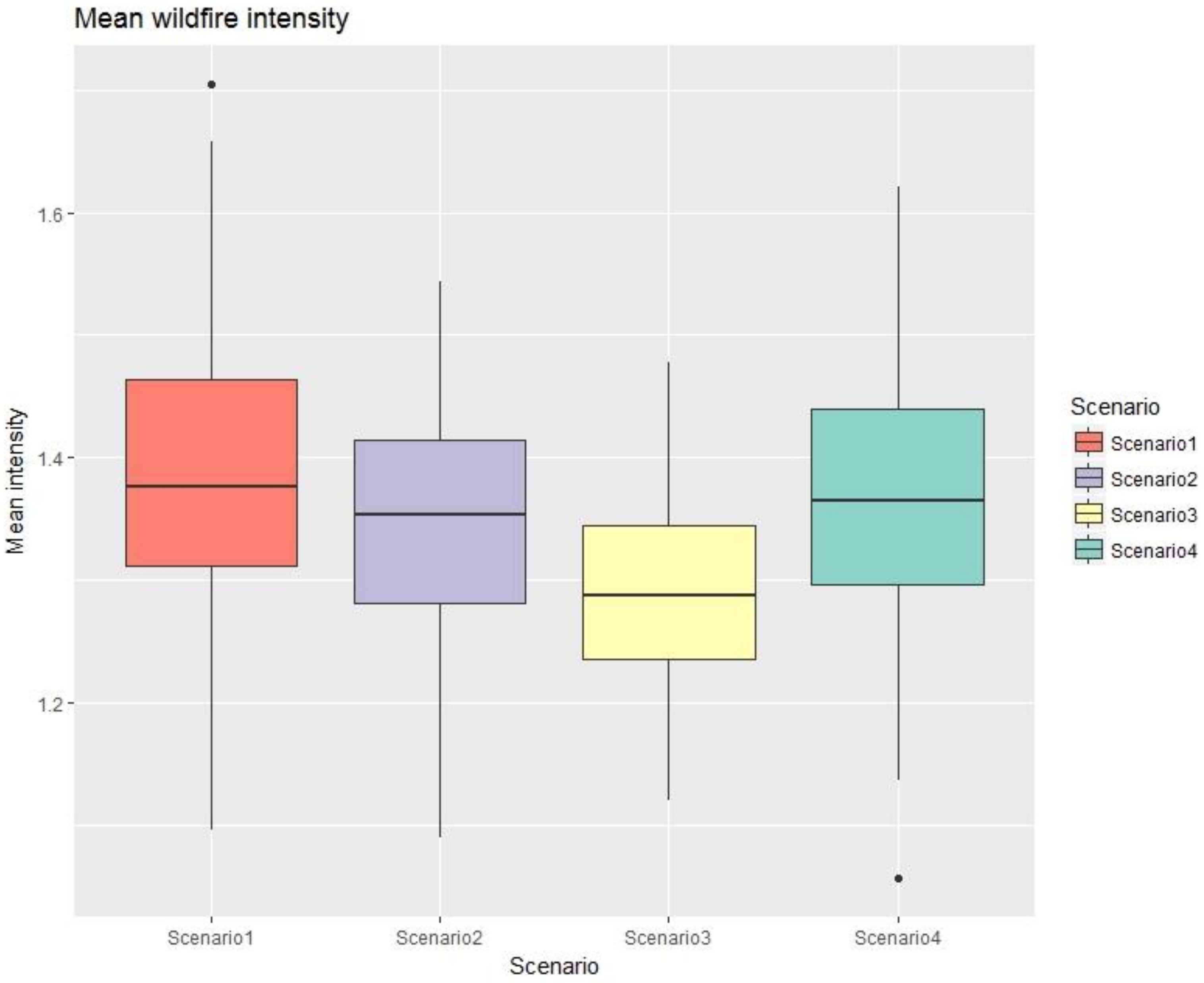
Mean biomass removed	0	48.5 tonnes/ha	34.9 tonnes/ha	42.5 tonnes/ha

Wildfire



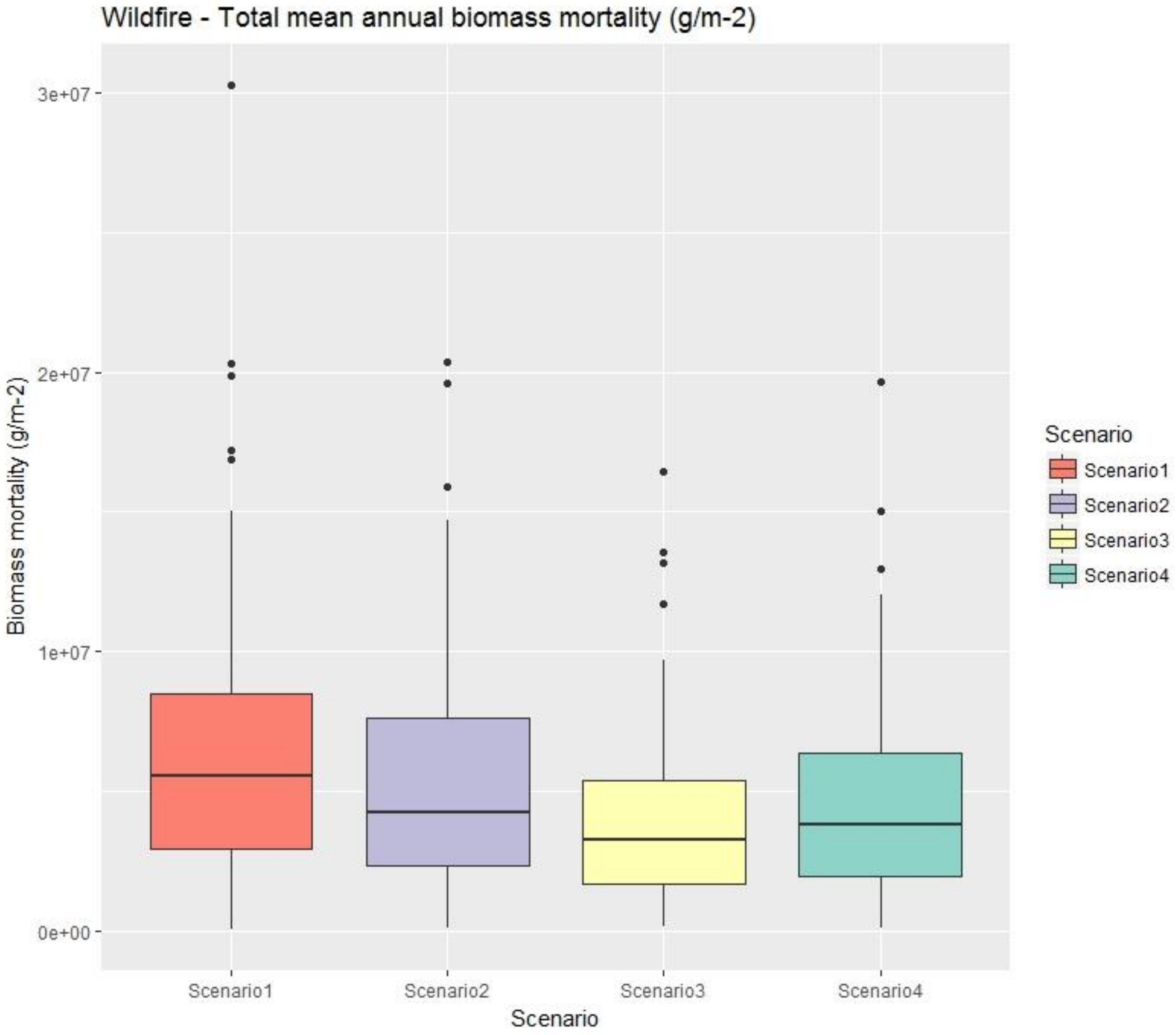
Wildfire: Hectares burned (decadal average) - landscape
Hecatres burned
7500
5000
2500
0
1
10
20
30
40
50
60
70
80
90
Year
Scenario
Scenario1
Scenario2
Scenario3
Scenario4

Wildfire



Mean wildfire intensity
Mean intensity
1.6
1.4
1.2
Scenario1
Scenario2
Scenario3
Scenario4
Scenario
Scenario
Scenario1
Scenario2
Scenario3
Scenario4

Wildfire



Wildfire - Total mean annual biomass mortality (g/m-2)
3e+07
2e+07
1e+07
0e+00
Biomass mortality (g/m-2)
Scenario1
Scenario2
Scenario3
Scenario4
Scenario
Scenario
Scenario1
Scenario2
Scenario3
Scenario4

Wildfire – Prescribed fires

<u>IADT scenario 4 design</u>
Total prescribed fire/yr: 1321 ha

LANDIS-II results – entire landscape

Mean total annual prescribed fire (ha)	1256.6ha
Mean prescribed fire size	41.8ha ± 2
Earliest recorded fire	Sept-16*
Latest recorded fire	Nov-1**
Mean number of fires/yr	30

Photo courtesy of Carl Skinner

*constrained in model
**emergent from fire weather/burn window

Insect mortality

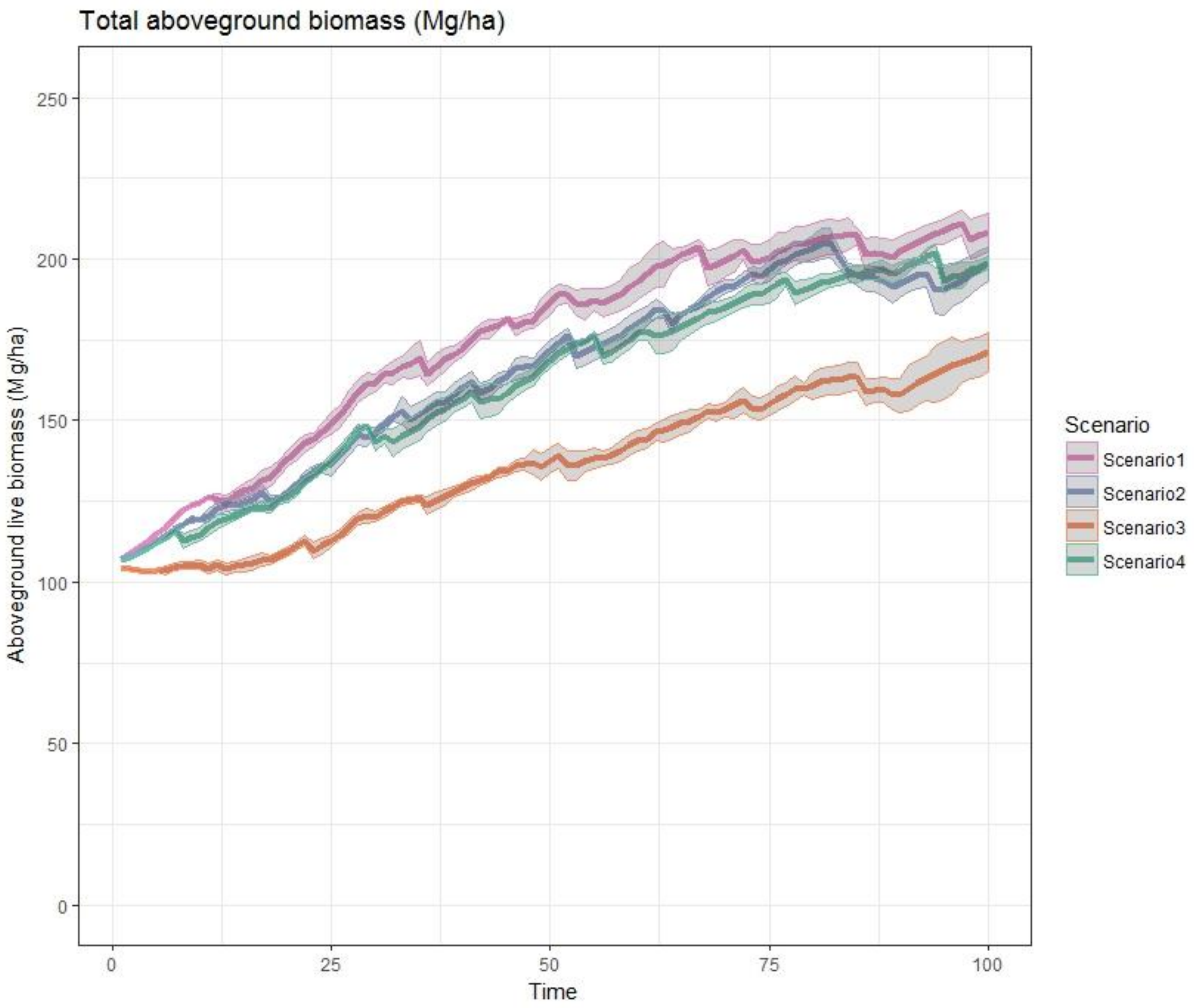
Bark beetle modeling

- 3 separate species: Jeffrey Pine Beetle, Mountain Pine Beetle, Fir Engraver
- Hosts are species (beetle/tree) and age specific
- Outbreak severity and total outbreak size are a product of host availability

LANDIS-II results – entire landscape

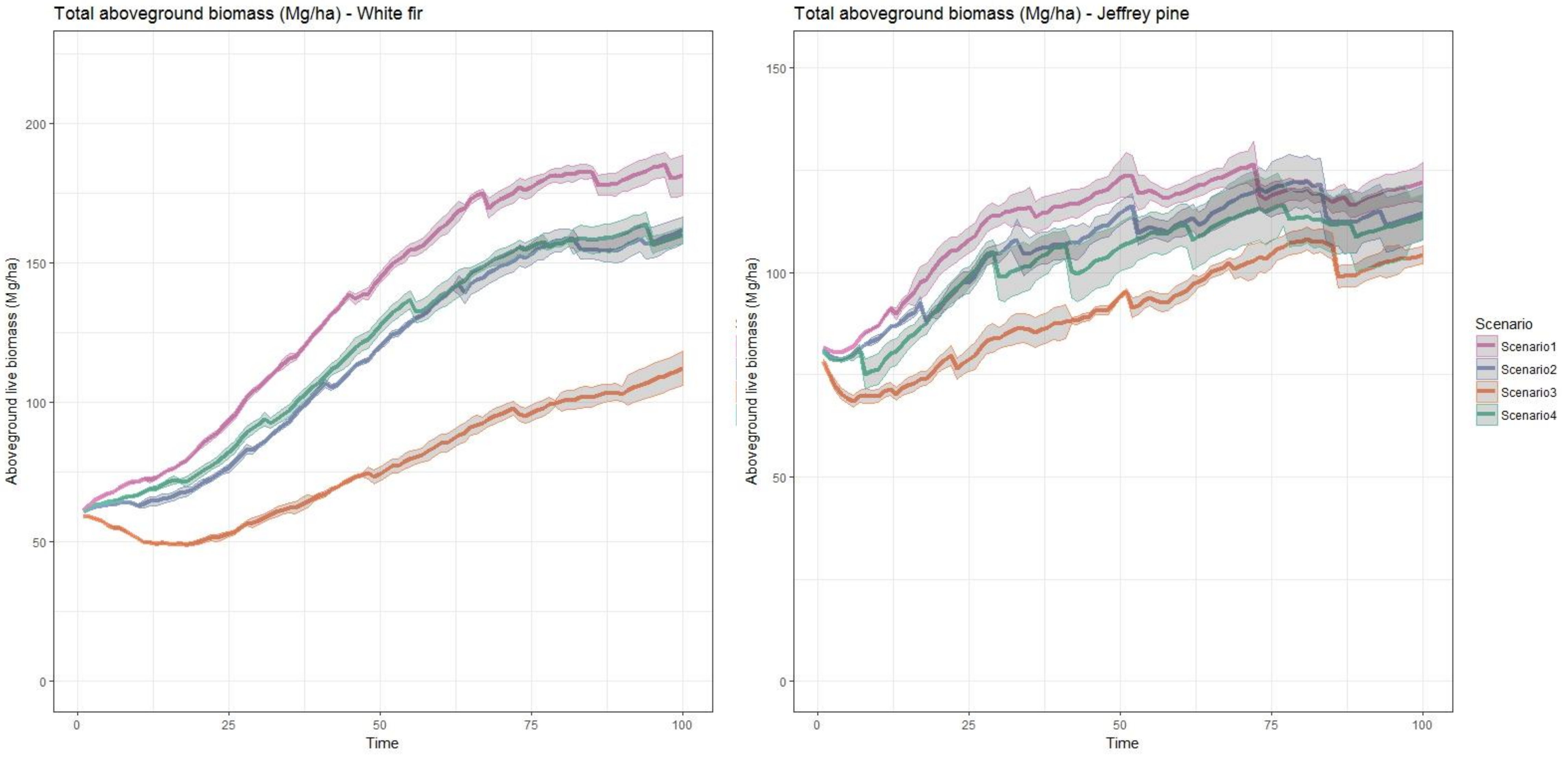
Scenario	Mean number of damaged sites (outbreak year)	Mean mortality in damaged sites
Scenario 1	1409ha	26244 (83765) g/m-2
Scenario 2	1298ha	21380 (75687) g/m-2
Scenario 3	1250ha	17290 (60140) g/m-2
Scenario 4	1321ha	18796 (63311) g/m-2

Biomass



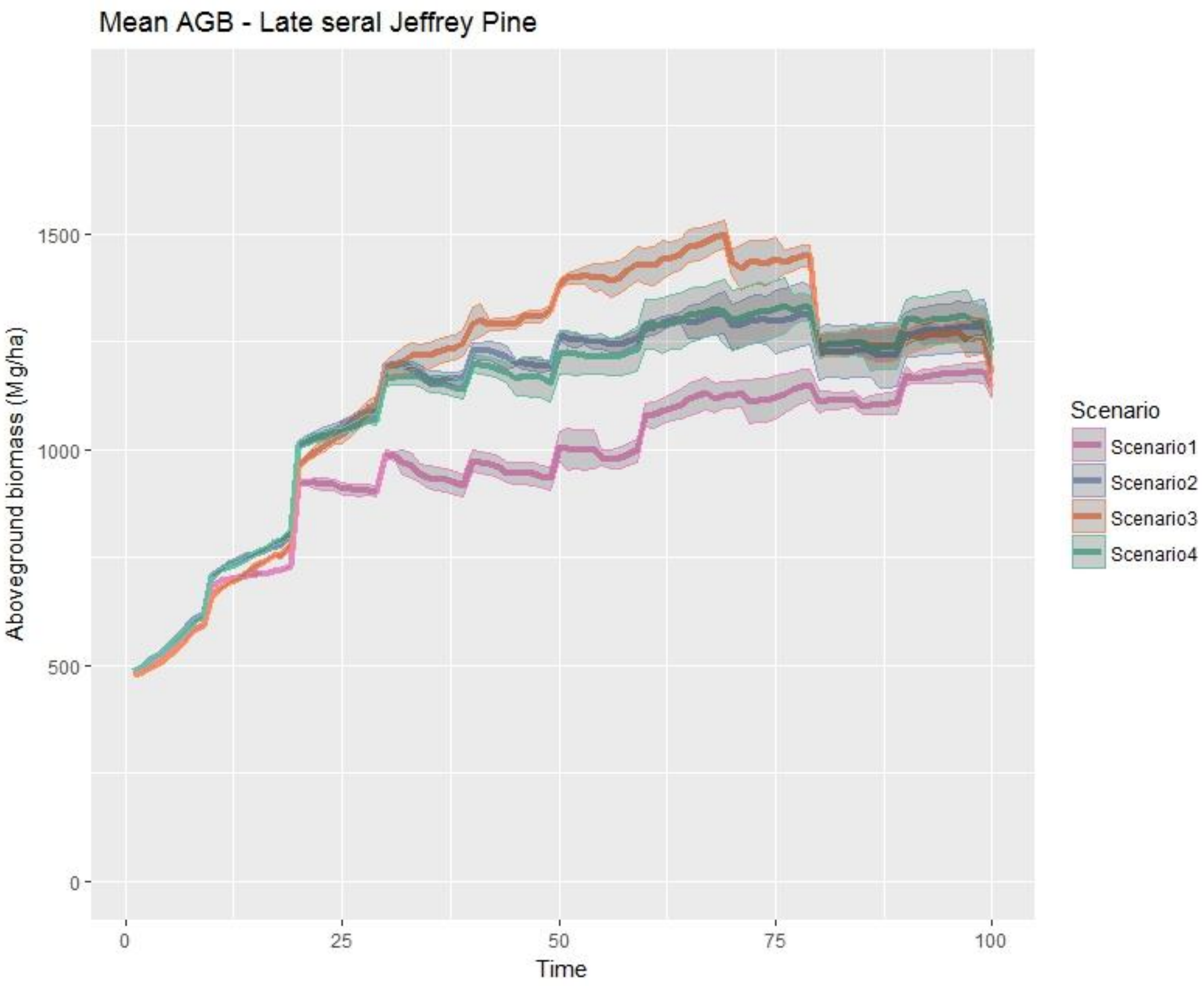
Total aboveground biomass (Mg/ha)
Aboveground live biomass (Mg/ha)
250
200
150
100
50
0
0
25
50
75
100
Time
Scenario
Scenario1
Scenario2
Scenario3
Scenario4

Biomass

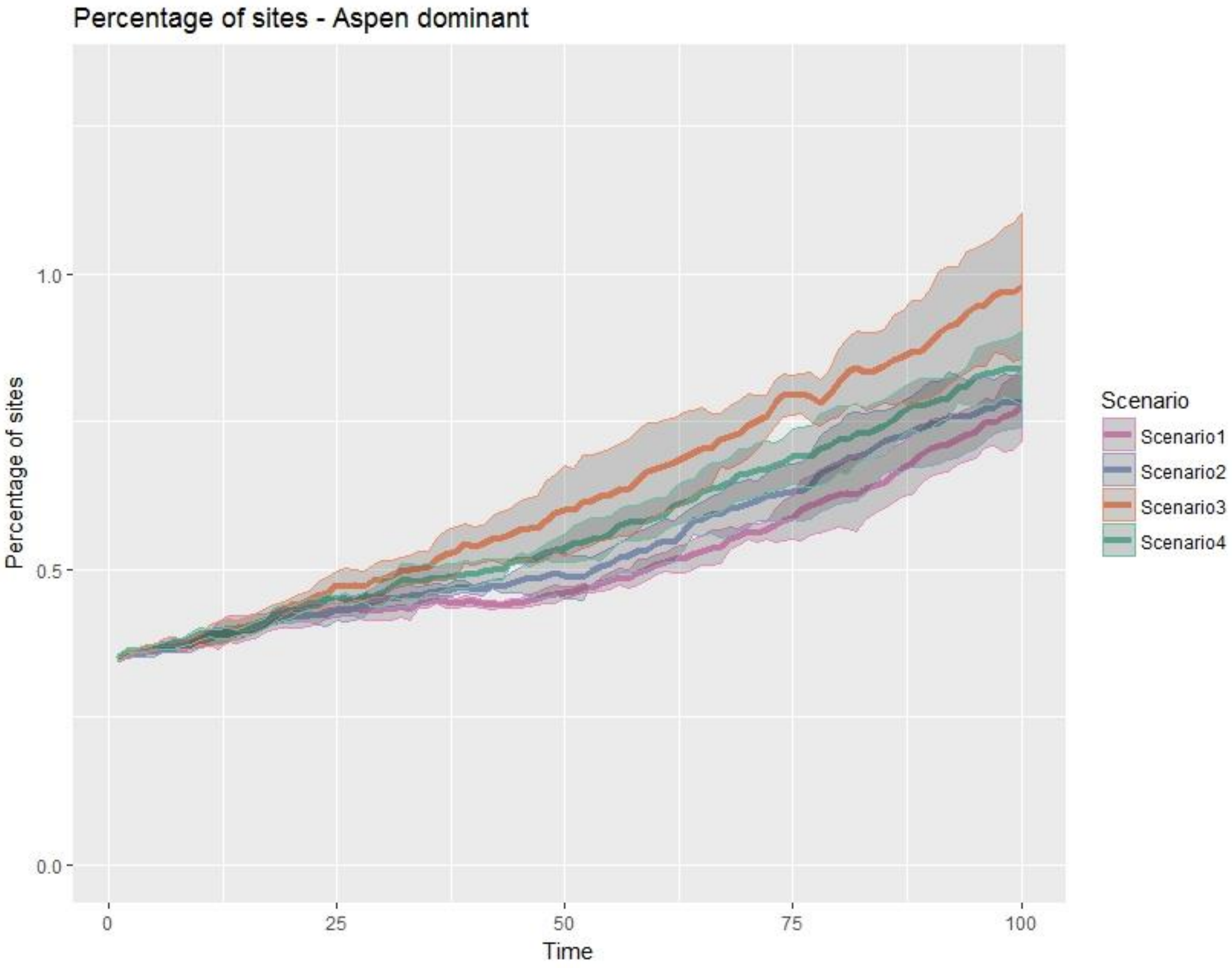


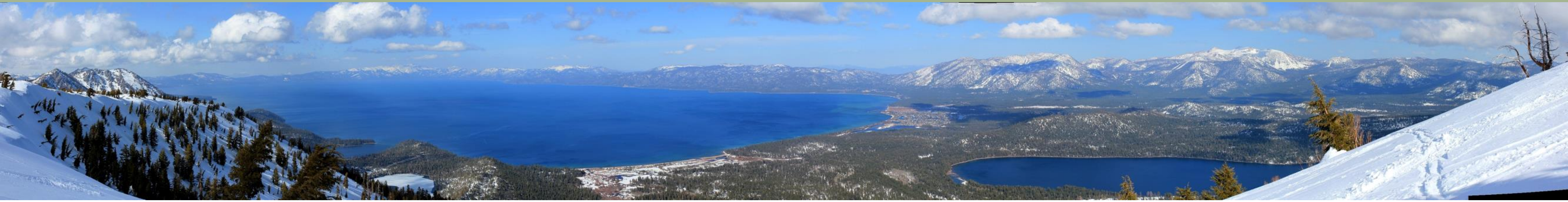
Total aboveground biomass (Mg/ha) - White fir
Aboveground live biomass (Mg/ha)
Time
0
25
50
75
100
50
100
150
200
Total aboveground biomass (Mg/ha) - Jeffrey pine
Aboveground live biomass (Mg/ha)
Time
Scenario
Scenario1
Scenario2
Scenario3
Scenario4

Late seral biomass



Aspen dominated sites





Thank you!

Questions/Discussion