SW Fire CLIME Vulnerability Assessment Tool
Webinar
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Megan M. Friggens
meganfriggens@fs.fed.us

SW Fire CLIME

Landscape Impacts of Fire and Climate Change in the Southwest : A Science-Management Partnership

Team:
Andi Thode, NAU (PI)
Anne Bradley, TNC
Windy Bunn, NPS
Zander Evans, Forest Guild
Don Falk, UA
William Flatley, UCA
Pete Fule, NAU
Megan Friggens, RMRS
Dave Gori, TNC
Shaula Hedwall, USFWS
Robert Keane, RMRS
Rachel Loehman, USGS
Jack Triepke, USFS
Craig Wilcox, USFS
Larissa Yocom, USU

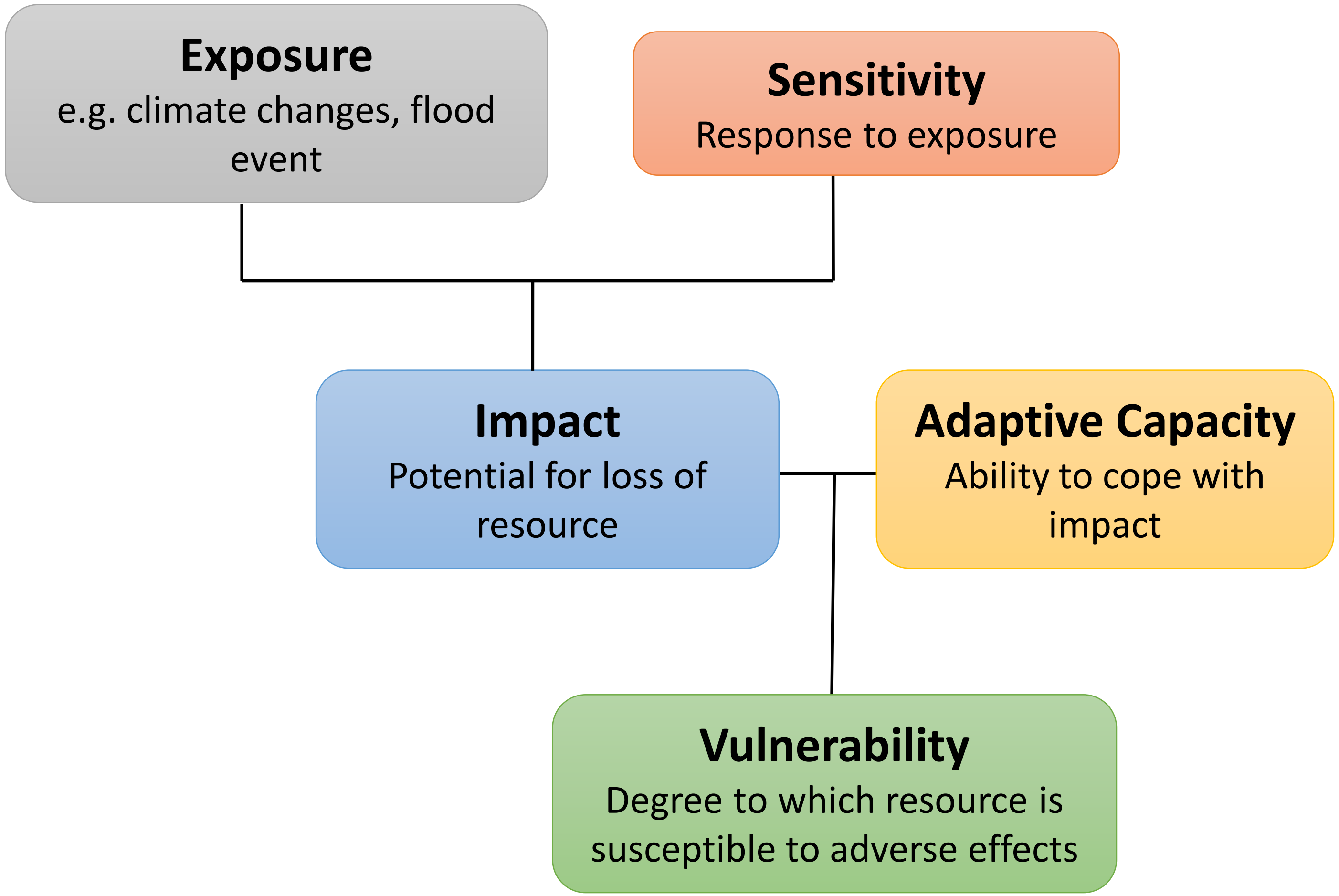
Objectives

1. Synthesize current knowledge of fire-climate dynamics
2. Assess vulnerability of SW ecosystems (e.g. mixed conifer vs. ponderosa pine) to shifts in climate and fire regimes
3. Model climate-fire-vegetation interactions with FireBGCv2 and LANDIS-II
4. Determine whether management actions can reduce ecosystem vulnerability under a range of future climates

Activities

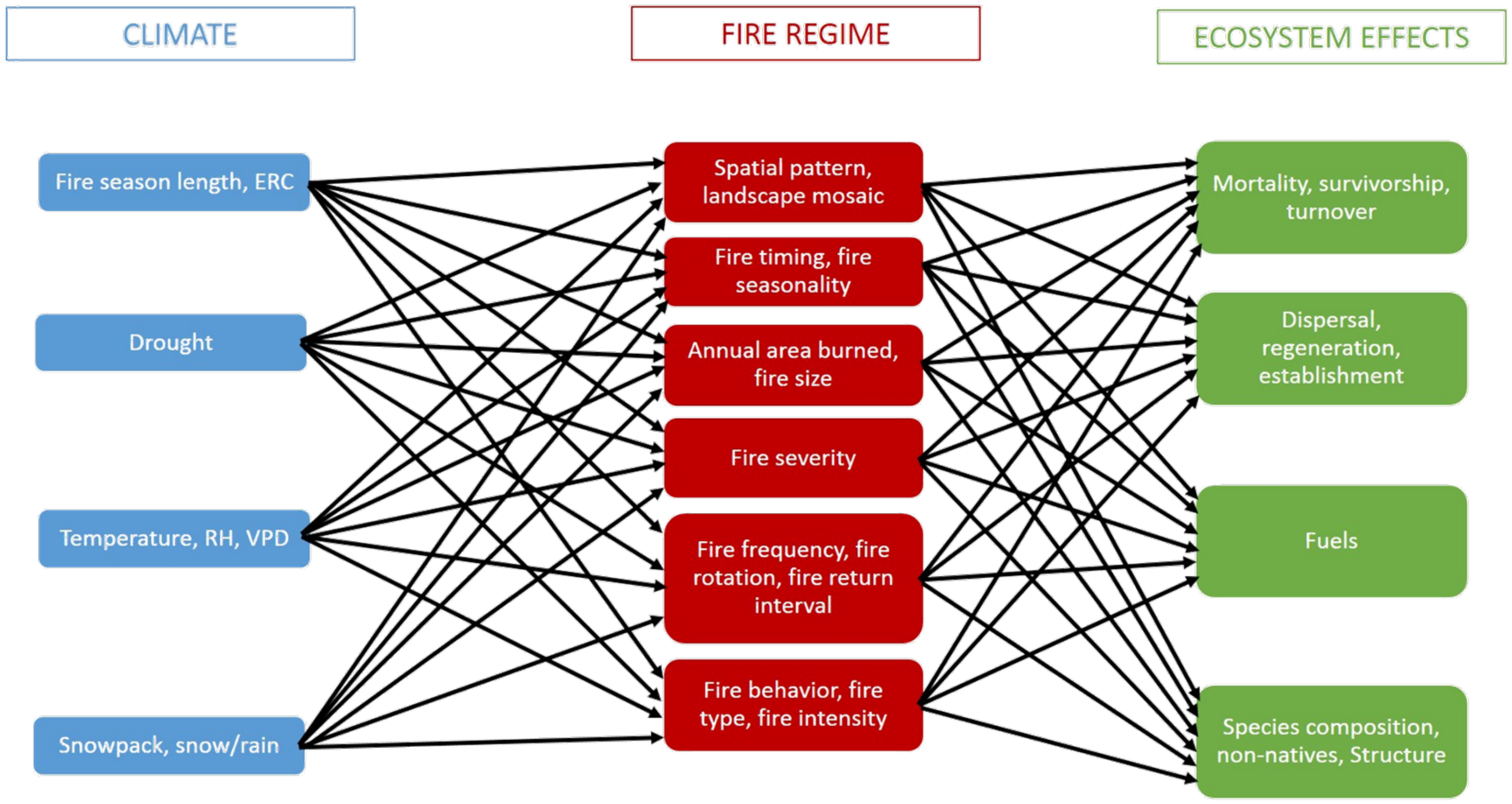
- Literature Review
- Manager-Scientist workshops
- Modeled projections for SW ecosystems under different climate-fire-management scenarios (Loehman et al. 2018)
- Framework to measure vulnerability of ecosystems under different climate-fire-management scenarios

Why vulnerability assessments?



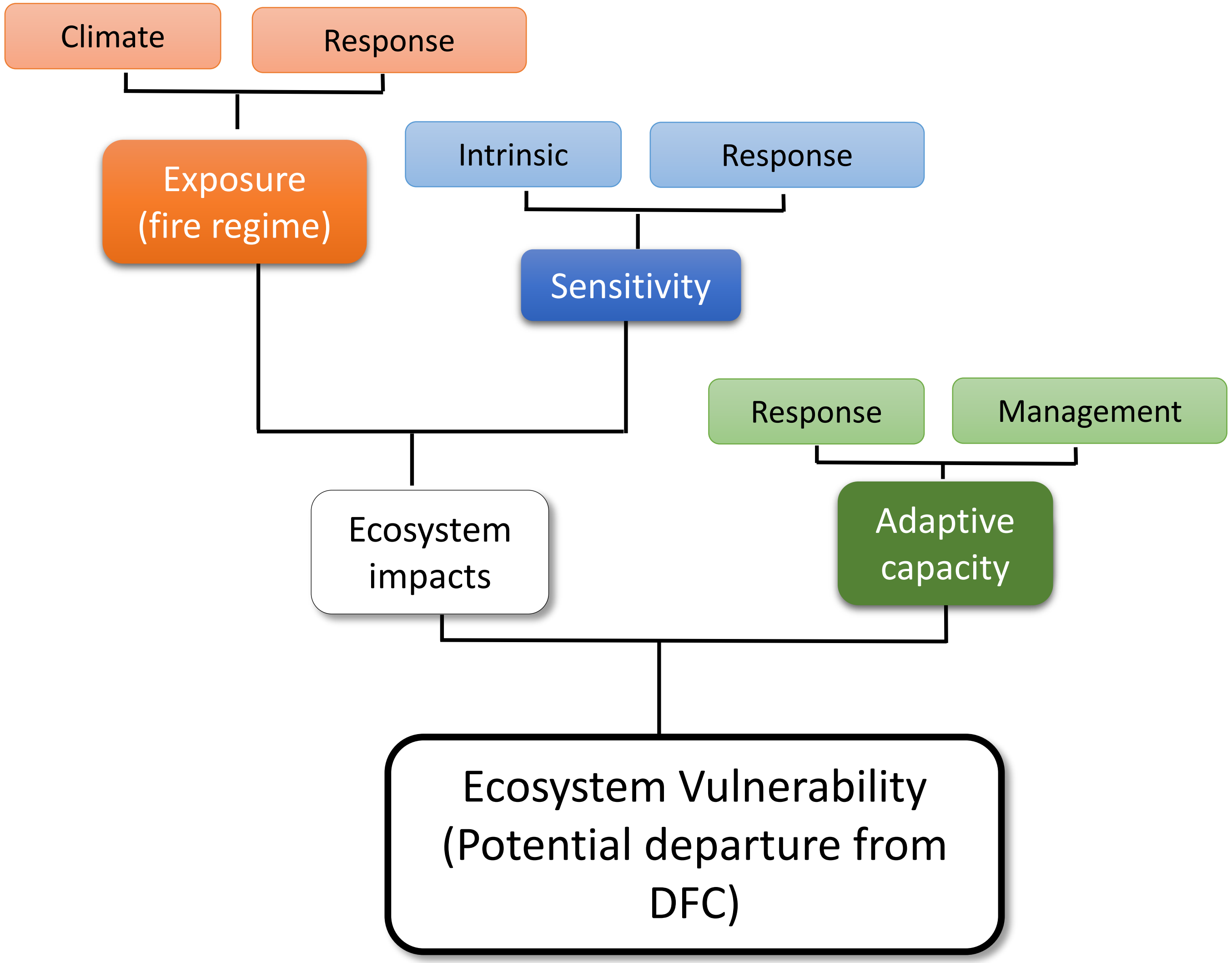
(IPCC 2007)

- Designed to identify and evaluate how and why something is negatively impacted by disturbance
- Used to prioritize actions and identify opportunities
- Provide guidance under uncertain futures


CLIMATE
FIRE REGIME
ECOSYSTEM EFFECTS
Fire season length, ERC
Drought
Temperature, RH, VPD
Snowpack, snow/rain
Spatial pattern, landscape mosaic
Fire timing, fire seasonality
Annual area burned, fire size
Fire severity
Fire frequency, fire rotation, fire return interval
Fire behavior, fire type, fire intensity
Mortality, survivorship, turnover
Dispersal, regeneration, establishment
Fuels
Species composition, non-natives, Structure

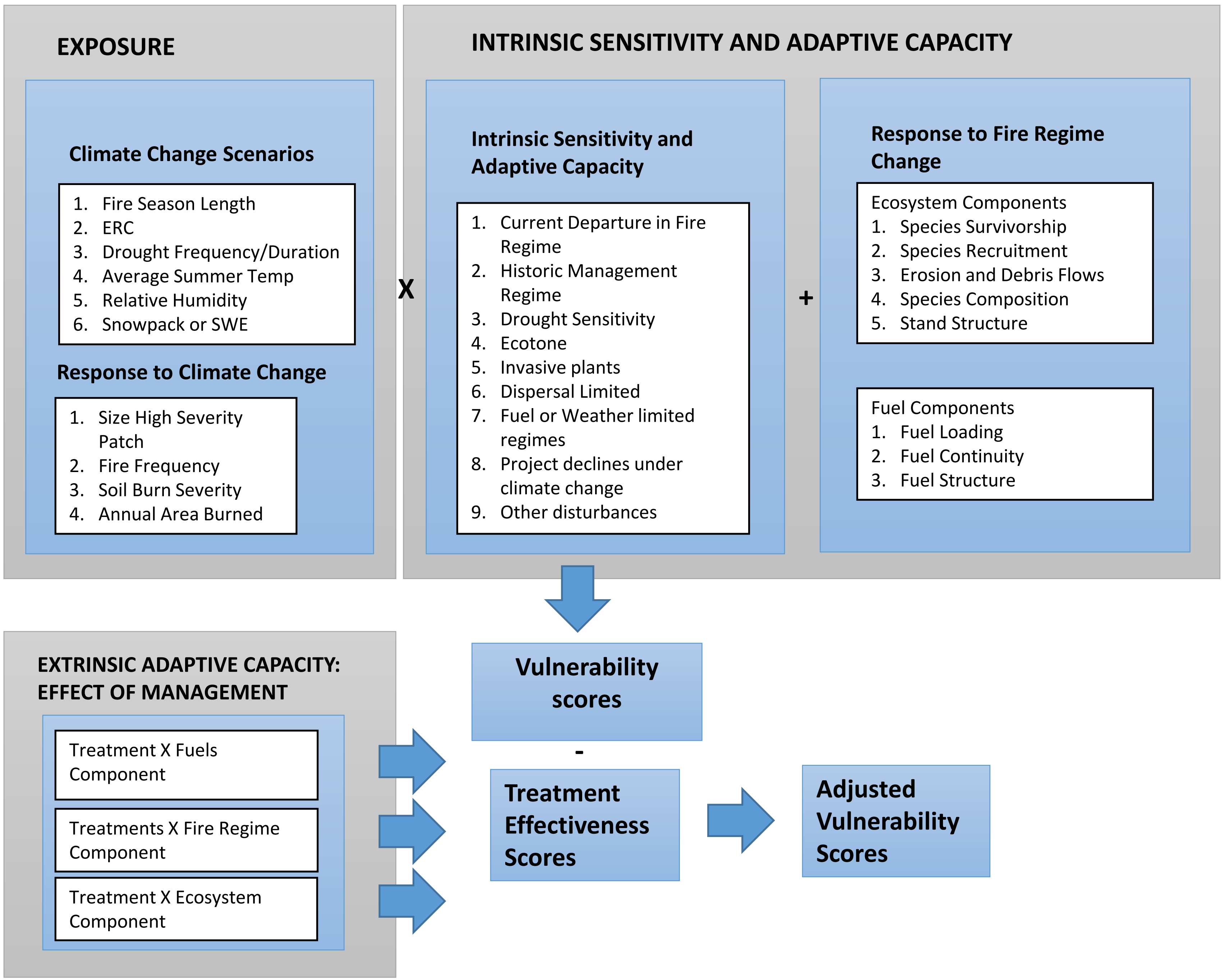
Additional Considerations

- Tool needs to be able to provide information for a wide variety of situations using a variety of data sources
  - Indicators to measure exposure, sensitivity and adaptive capacity must be reliable
  - Definition of negative must be consistent but flexible
- Recognize not all change is negative
- Framework needs to incorporate impacts of management actions



1. Simple additive system based on core fire, ecosystem and fuel indicators
2. Desired Future Conditions (DFC) are used as baseline
3. Response based system that considers change and nature of that change: Response can be positive or negative

Framework and Core Components



DEMO

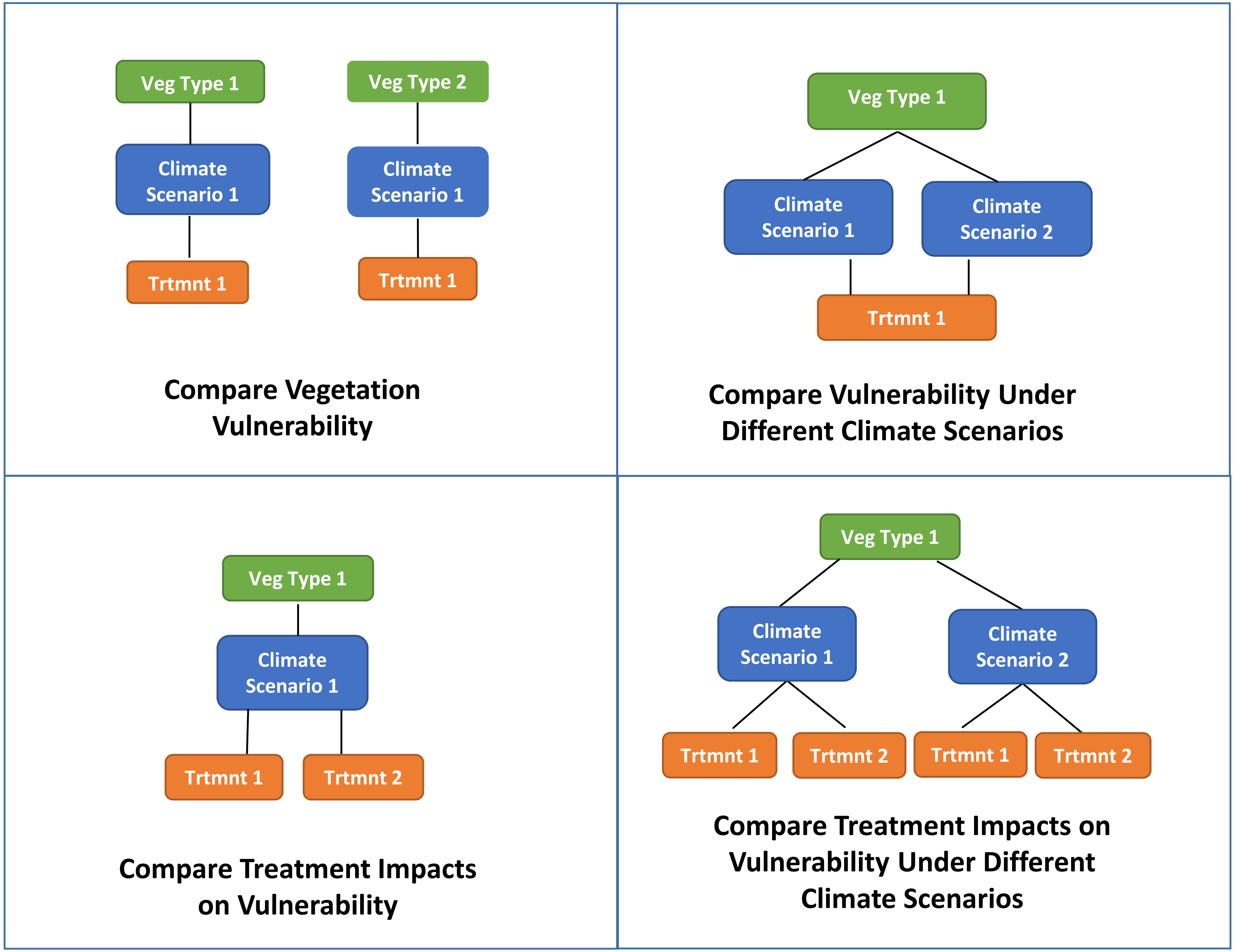
The Fire CLIME Vulnerability Assessment Tool

Outputs

- Impact scores:
  - Fire regime components
  - Ecosystem components
  - Fuel components
- Uncertainty/Confidence scores for all responses
- Vulnerability and Impact Score before and after Treatment

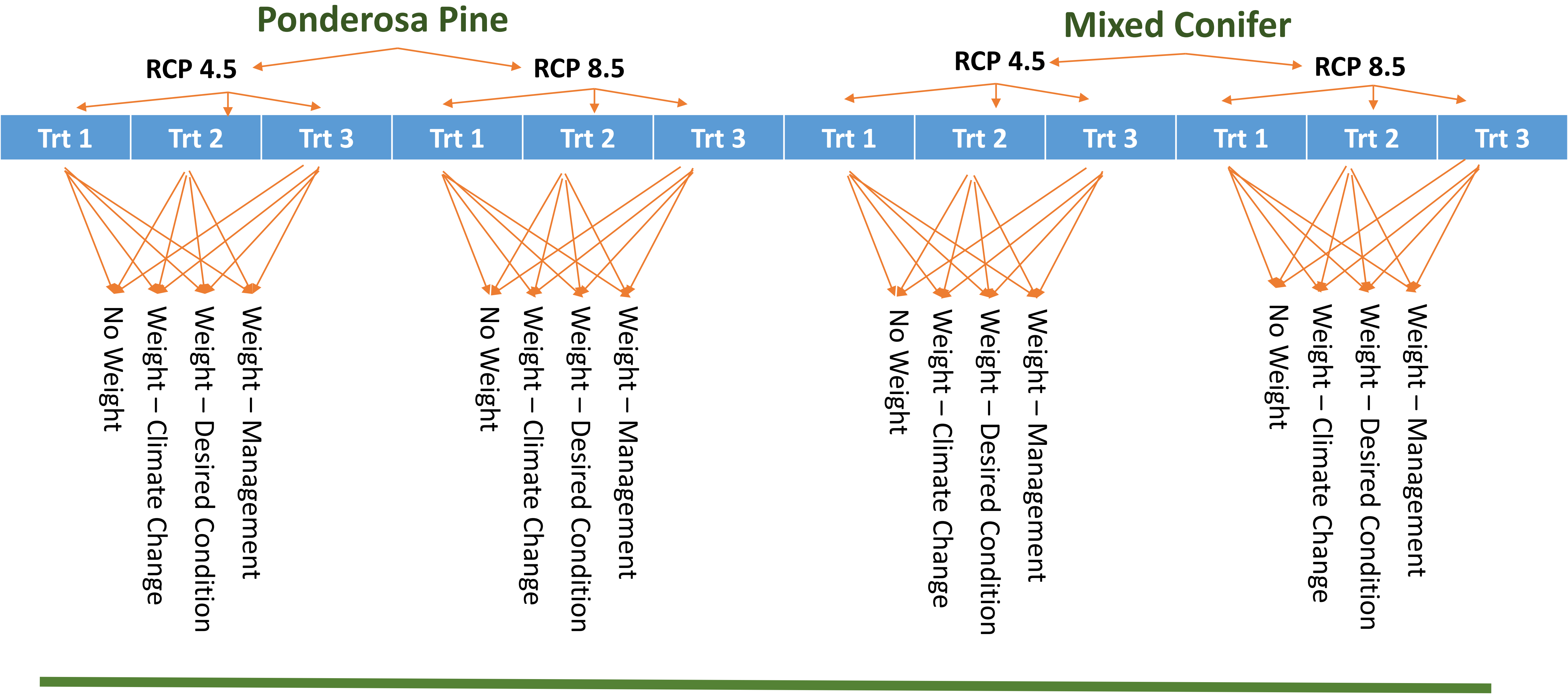
With these outputs users can:

- Identify climate-driven changes in individual fire regime components
- Link fire regime shifts to ecosystem impacts
- Incorporate climate uncertainties
- Compare across ecosystems, treatments
- Prioritize areas of concern


Veg Type 1
Climate Scenario 1
Trtmnt 1
Veg Type 2
Climate Scenario 1
Trtmnt 1
Compare Vegetation Vulnerability
Veg Type 1
Climate Scenario 1
Climate Scenario 2
Trtmnt 1
Compare Vulnerability Under Different Climate Scenarios
Veg Type 1
Climate Scenario 1
Trtmnt 1
Trtmnt 2
Compare Treatment Impacts on Vulnerability
Veg Type 1
Climate Scenario 1
Climate Scenario 2
Trtmnt 1
Trtmnt 2
Trtmnt 1
Trtmnt 2
Compare Treatment Impacts on Vulnerability Under Different Climate Scenarios

Example 1: Ponderosa Pine and Mixed Conifer Ecosystems in the Jemez Mountains

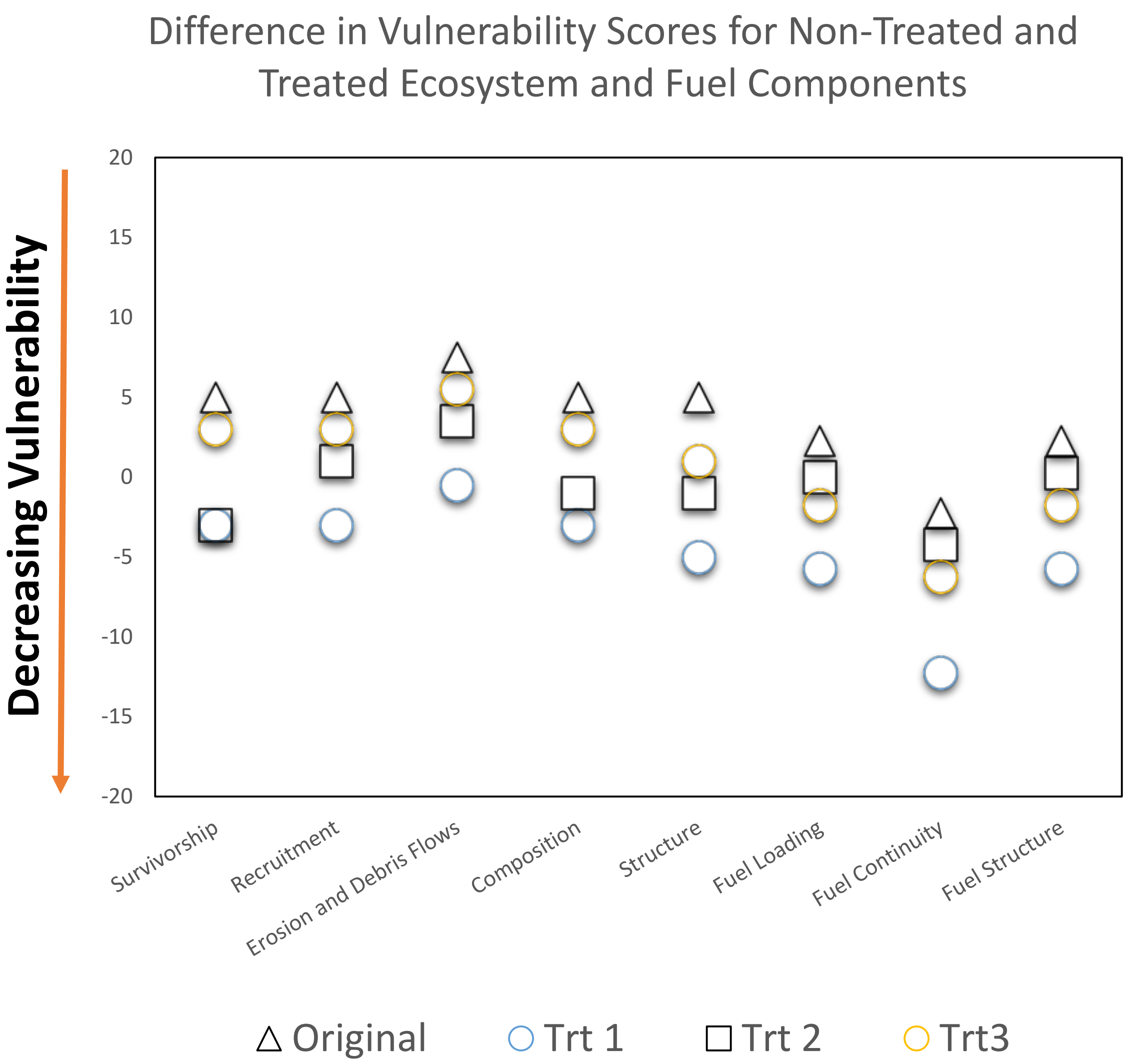
- Literature Based Case Study ->Stephanie Mueller
- Warm-dry future climate trajectory (CCSM4 CMIP5 RCP 4.5) with average global increase in temperature of 1.8°C (2100) and increased aridity and periods of drought in the Southwest (Collins et al., 2013).
- Three treatment inputs based on the 2015 Final Environmental Impact Statement (EIS) for the Southwest Jemez Mountains Landscape Restoration Project on the Jemez Ranger District (USDA Forest Service, 2015).
- Time period (outcome date): 2050



Ponderosa Pine
RCP 4.5
RCP 8.5
Mixed Conifer
RCP 4.5
RCP 8.5
Trt 1
Trt 2
Trt 3
Trt 1
Trt 2
Trt 3
Trt 1
Trt 2
Trt 3
Trt 1
Trt 2
Trt 3
No Weight
Weight – Climate Change
Weight – Desired Condition
Weight – Management
No Weight
Weight – Climate Change
Weight – Desired Condition
Weight – Management
No Weight
Weight – Climate Change
Weight – Desired Condition
Weight – Management
No Weight
Weight – Climate Change
Weight – Desired Condition
Weight – Management

Treatment Variations

Duration Treatments	Desired Date	Treatment 1	Treatment 2	Treatment 3
This work will be done over 8-10 years or until objective are met	2050	**Mechanically treat ~29,900 acres of PIPO ecosystem; prescribed fire on ~77,000 acres to reduce post-thin slash; additional prescribed fire on non-treated areas**	**No RX fire alternative. Mechanically treat same 29,900 acres and masticate slash material or lop and scatter on site; reduce prescribed fire by 41% to minimize smoke emissions**	**No action alternative. No change to current management. Minimal mechanical thin (~900 acres); prescribed fire on ~18,400 acres.**



Treatment 1	Treatment 2	Treatment 3
Mechanically treat approx. 29,900 acres of fire-adapted PIPO ecosystems and use prescribed fire on approx. 77,000 acres to reduce post-thin slash.	**No RX fire alternative. Mechanically treat same 29,900 acres and masticate slash material or lop and scatter on site.**	**No action alternative. No change to current management. Mechanical thin of approx. 900 acres of PIPO and use prescribed fire on approx. 18,400 acres.**

Weighted Response Data

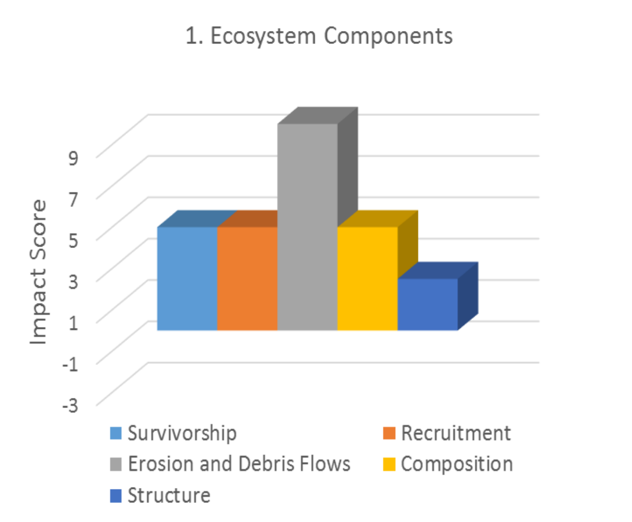
<table>
<tr><th></th><th></th><th>Some characteristics will be more strongly influenced by climate/fire regime changes than others</th><th></th><th>Certain characteristics have a stronger influence on desired future conditions</th><th></th><th>Management focus is on a certain characteristic.</th></tr>
<tr><td>High severity patch size</td><td>1</td><td rowspan="4">In the near-term future, increasing drought stress and length of fire season will create more opportunities for conditions that are conducive to fire ignition and spread across the landscape. This will affect the frequency of fire, thereby increasing the amount of area burned annually, and likely will include more and larger high-severity patches.</td><td>1</td><td rowspan="4">Large, high-severity patches of fire will likely have the largest impact in PIPO ecosystems. If high-severity fire also results in higher soil-burn severity (likely) this fire regime component will also have a strong influence on future desired conditions; however, fire frequency and annual area burned are more 'washy'. Although both are expected to increase in the near-term future, within the projected time frame to 2050, these may have little effect at the landscape level and may either benefit or be a detriment to the stand depending on the 'type' (severity, pattern) of fire at that time.</td><td>1</td><td rowspan="4">In general, within PIPO stands, managers focus on reducing the potential for high-severity fire and large-high severity patches. Also, with recent fire causing massive erosion and damage post-fire, soil burn severity is a large driver of management for communities-at-risk, especially in areas with lots of terrain near communities. Although treatments might uses fire, thereby increasing the fire frequency or amount of acres burned on the ground, in some sense, it is to reduce fire outside of the fire season when it is most difficult to control.</td></tr>
<tr><td>Fire Frequency</td><td>1</td><td>3</td><td>2</td></tr>
<tr><td>Soil Burn Severity</td><td>1</td><td>2</td><td>1</td></tr>
<tr><td>Annual area burned</td><td>1</td><td>3</td><td>2</td></tr>
<tr><td>Species Survivorship</td><td>2</td><td rowspan="5">Initially, large patches of severe wildfire will likely result in erosion and debris flows across large areas. Furthermore, these large patches along with increased drought due to climate change will begin to affect species recruitment as conditions for establishment of PIPO seedlings become poor. More large and severe fires will also begin to affect stand structure and composition as novel ecosystem trajectories become more common; however at the landscape level, these changes will likely occur beyond the 2050 time-frame</td><td>2</td><td rowspan="5">Pre-European conditions in ponderosa pine forests contained uneven-aged, open stands with groups of trees with on average 11.7 – 124 trees/acre. Returning to this stand structure would have the strongest influence on reaching desired ecological conditions and returning the fire regime to desired conditions, as well as affecting the other ecosystem components. Also, there has been an increased emphasis on decreasing erosion around communities at-risk, so reducing that risk is very desirable.</td><td>3</td><td rowspan="5">As a manager, my goal is to return the structure of my stand in order to reduce the potential for severe, crown-fire. Species composition naturally follows this goal, but is still secondary to structure. Also, with recent fire causing massive erosion and damage post-fire, protecting areas where erosion is likely is also a priority for at-risk communities and ecosystems in the area. Finally, though long delays in PIPO recruitment post fire have prompted recommendations for planting trees in some cases, post-fire planting along with abundant post-fire natural tree regeneration in some regions may lead to increased future fire severity. Species recruitment may become an issue with increasing climate change beyond 2050.</td></tr>
<tr><td>Species Recruitment</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>Erosion and Debris Flows</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>Species Composition</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>Stand Structure</td><td>2</td><td>1</td><td>1</td></tr>
<tr><td>Fuel Loading</td><td>3</td><td rowspan="3">Considering the timeline, initially an increase in fire, may result in alternative forest types, i.e. move toward more shrub-dominated ecosystems which would cause a large change in species composition thereby affecting fuel composition. It is possible that more fire may reduce fuel loading in some areas, however initially, large-severe fires may create more fuels due to incomplete combustion of large fuel classes.</td><td>1</td><td rowspan="3">The amount of fuel and the fuel connectivity (structure) will greatly affect how fire moves throughout the stand, especially as it continues in increase and become more dense and connected. The fuel composition matters only in that it may affect the loading and structure, but even too much of the 'native dominant' species may have detrimental effects of the stands.</td><td>1</td><td rowspan="3">Removing excess fuel that carry fire is the first management priority. Then, reducing the ladder fuels and affecting the fuel structure is the second priority in most cases.</td></tr>
<tr><td>Fuel Structure</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>Fuel Continuity</td><td>1</td><td>2</td><td>3</td></tr>
</table>

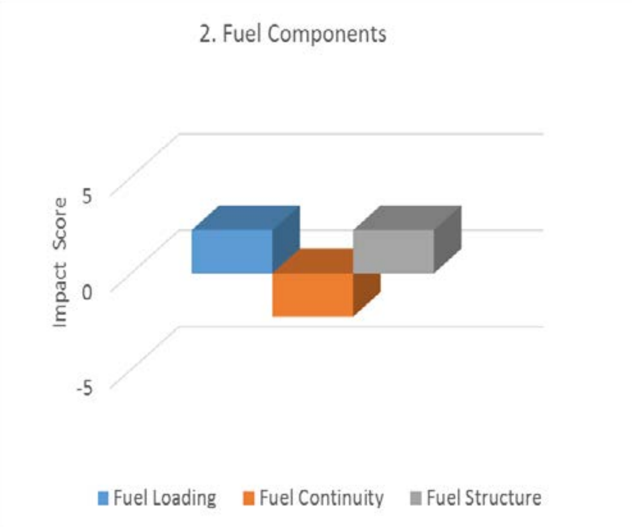
Summary: Results

Table 2.1. Scores	reported on scale of -10 to +10	reported on scale of -10 to +10	reported on scale of -10 to +10	reported on scale of -10 to +10
	No Weight	Climate Change	DFC	Management
Overall Vulnerability *	5.3	5.3	6.4	6.3
Overall Exposure	10.0	10.0	10.0	10.0
Intrinsic Sensitivity	9.2	9.2	9.2	9.2
Average Response Score	3.7	3.7	3.7	3.7
Average Impact	3.2	3.2	2.9	2.8

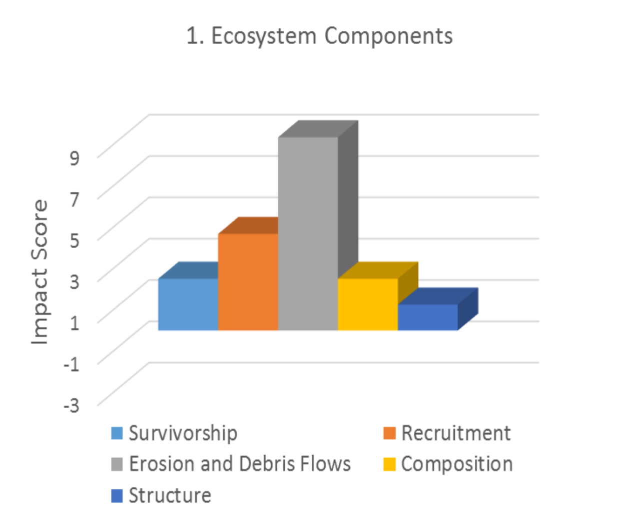
Summary: Results

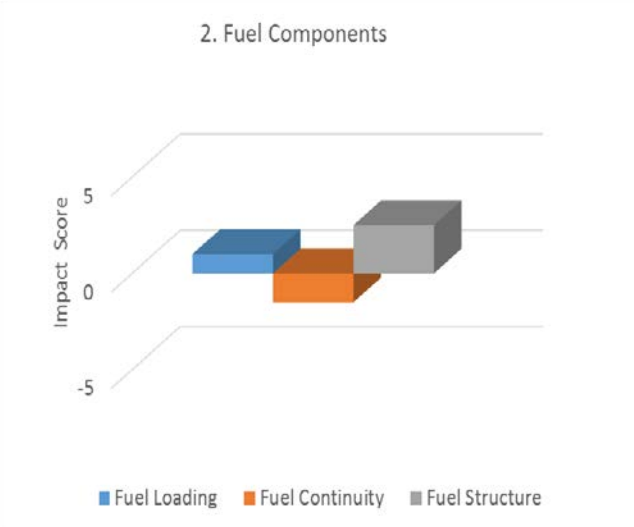
No Weight



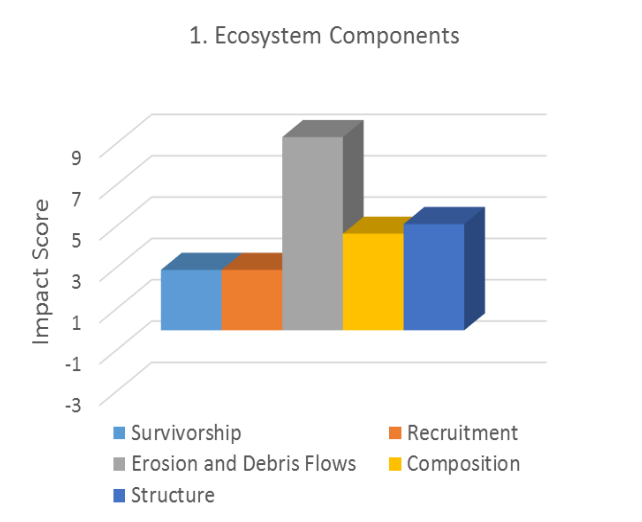


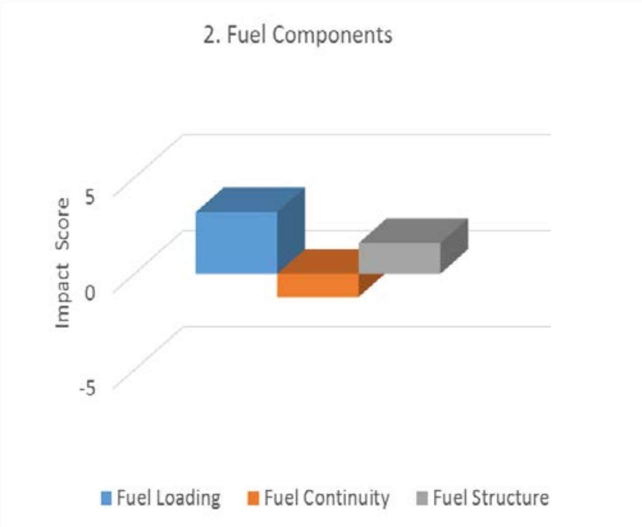
Climate Change



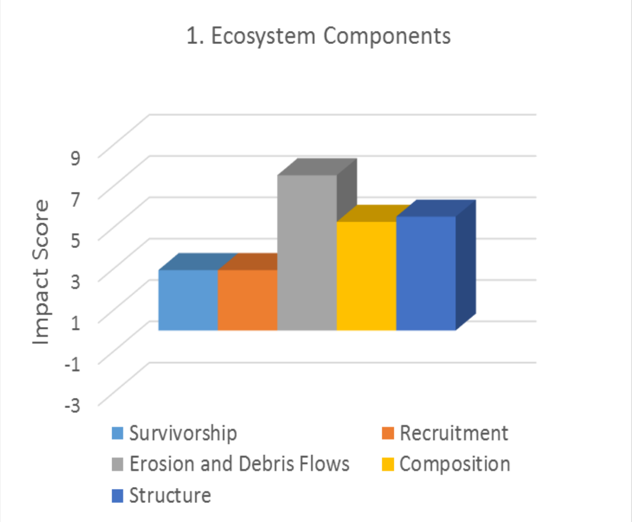


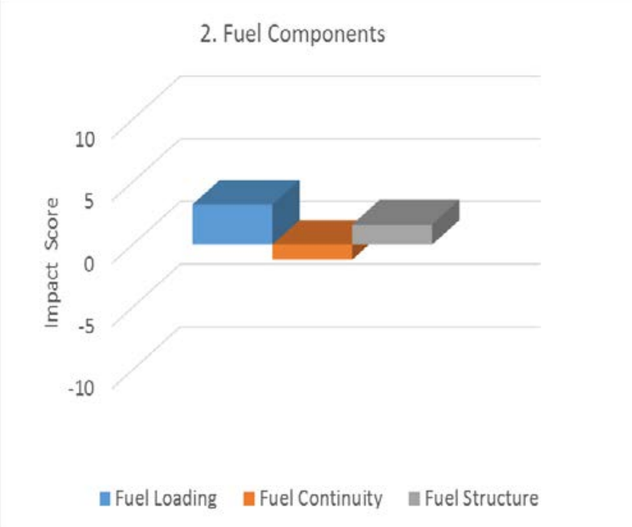
DFC





Management





Summary: Results

First | Second | Bottom

Impact Scores	reported on scale of -10 to +10	reported on scale of -10 to +10	reported on scale of -10 to +10	reported on scale of -10 to +10
	No Weight	Climate Change	DFC	Management
Survivorship	5.0	2.5	2.9	2.9
Recruitment	5.0	4.7	2.9	2.9
Erosion and Debris Flows	10.0	9.4	9.4	7.5
Composition	5.0	2.5	4.7	5.3
Structure	2.5	1.3	5.1	5.5
Fuel Loading	2.3	1.0	3.2	3.5
Fuel Continuity	-2.3	-1.5	-1.2	-0.9
Fuel Structure	2.3	2.5	1.6	1.4

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With these outputs users can:

- Identify climate-driven changes in individual fire regime components
- Link fire regime shifts to ecosystem impacts
- Incorporate climate uncertainties
- Compare across ecosystems, treatments
- Prioritize areas of concern

Can use a combination of expert opinion, lit review*, field data…

Data Inputs	Purpose
Climate Scenarios	Identifies potential exposure via change in climate variables with direct influence on fire behavior
Historic Fire and Management Regime	Provides basis of comparison, initial conditions that might influence vulnerability
Current Conditions	Identifies status and conditions that may indicate increased sensitivity (reduce resilience)
Desired Future Conditions (DFC)	Identifies basis by which vulnerability is measured. All entries are based on whether changes will bring component further or closer to DFC.
DFC: Fire regime	Identifies management objectives in order to structure analysis of whether exposure leads to undesirable outcomes
DFC: Ecosystem	Identifies management objectives in order to structure analysis of whether exposure leads to undesirable outcomes
Response of fire regime, ecosystem and fuel components to climate	Responses translate to potential exposure, sensitivity, and adaptive capacity of each component, which are tallied to quantify impact and ultimately vulnerability
Treatments	Identifies the purpose and parameters of treatments in order to structure analysis of treatment effectiveness

Data requiring technical data*:	
Climate Change	Fire Season Length; ERC; Drought Frequency/Duration; Average Summer Temp; Relative Humidity; Snowpack or SWE
Response of fire regime, ecosystem and fuel components to climate	Expected trends in 4 fire regime components and consequences of those changes for 5 ecosystem and 3 fuel components.
Data requiring some input from managers:	
Historic Fire and Management Regime	Initial conditions and factors that might influence vulnerability
Data requiring input from managers:	
Current status conditions	Fire regime departure from desired, presence of invasive species, other disturbances present in ecosystem, etc.
Desired Future Conditions (DFC)	The basis for DFC- e.g. historic conditions, climate-adapted landscape, management goals, planning documents
DFC: Fire regime	Identify ideal: frequency, annual area burned and severity
DFC: Ecosystems and fuels	Identify ideal: Seral stage, species composition, and stand structure
Treatments	Identify the purpose and parameters of treatments (e.g. duration, application frequency and timing, total area, spatial distribution, type of activity, etc.

Core Indicators

Climate	Fire Regime Characteristic	Landscape Components Ecosystem	Fuels
1. Fire season Length	1. High Severity Patch Size	1. Survivorship	1. Fuel Loading
2. ERC	2. Fire Frequency	2. Species Recruitment	2. Fuel Continuity
3. Drought frequency and duration	3. Soil Burn Severity	3. Erosion and Debris Flows	3. Fuel Structure
4. Average summer Temperature	4. Annual area burned	4. Species Composition	
5. Relative Humidity		5. Stand structure	
6. Snowpack or SWE			