Supplement S3. Fire Manager Survey

Summary: We invited 17 wildfire managers to participate in an online survey. Invitees were purposively selected from various state and federal agencies for their knowledge of wildfire behavior in western Oregon, including oak vegetation types. Survey responses were submitted by May 21, 2012. Ten invitees participated in the survey for a response rate of 59%. We used the survey to check their agreement with, or recommended adjustments to, our first principles, and to identify their expectations for fire effects on selected forest stand types under both current 97th percentile fire weather conditions as well as more extreme 97th percentile conditions projected under the Hadley GCM.

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Fire Manager Survey

Fire Behavior and Effects under Current and Future Climate:
The Southern Willamette Valley Floor and Foothills
A research survey conducted jointly by the UO, OSU, and USFS with support from the National Science Foundation

We are asking for your help to better understand fire behavior and effects in the Willamette Valley floor and foothills. The information collected in this questionnaire will be used to improve our wildfire simulation models and better understand how wildfire might change in the future.

This questionnaire has three sections. The initial section is about general fire behavior principles for Willamette Valley vegetation types. The following two sections ask 1 to 2 questions about each of 9 vegetation types. The first is about fire behavior in extreme fire weather conditions under current and projected future climate conditions, and the final section is about flame length thresholds for tree mortality. For each section we've repeated a set of photos and stand characteristics descriptions for each vegetation type for easy reference.

Please complete the questionnaire by **MAY 21, 2012**. If you would like the option to complete the questionnaire on a paper form, or have any other questions please contact:

Jane Kertis, US Forest Service (541-750-7192, jkertis@fs.fed.us)
or
Bart Johnson, University of Oregon (541-346-2235, bartj@uoregon.edu)

Thank you in advance for your help.

Instructions:
Please read carefully through each question and answer as best you can using your experience and best judgment.
Check the answer that you feel is most appropriate.
Provide comments if desired.

General Principles for Modeling Willamette Valley Foothills Wildfire

First, we would like your perspectives on a number of principles important for modeling wildfire in the southern Willamette Valley foothills.

1) How might the effects of a surface fire differ among the following two types of forest stands **if the flame lengths were the same**? Assume the two forest types have similar tree species and diameter distributions. (Please check the answer you feel is most accurate)

- Forest stand A has an open canopy, sparse trees and a high level of herbaceous fuels (leading to a faster rate of spread and shorter residence time).
- Forest stand B has a closed canopy, more trees and more woody ground fuels (leading to a slower rate of spread and longer residence time).

- ○ Forest stand A would suffer lower tree mortality rates than forest stand B
- ○ Forest stand A would suffer tree higher mortality rates than forest stand B
- ○ There would be no difference in tree mortality rates between forest stand A and forest stand B

Please give a brief explanation of why you selected the answer you did:

2) How much do you agree or disagree with the following statement?

For a surface fire at a given flame length and all else being equal, **a mutli-layer stand** with a mixture of large diameter trees and smaller diameter trees will experience greater tree mortality rates than a **one-layer stand** with only larger diameter trees. (Please select one answer)

- ○ Completely agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Completely disagree

Please give a brief explanation of why you selected the answer you did:

3) For the following diameter size classes (DBH = diameter at breast height), is Oregon white oak more, equally, or less likely to suffer aboveground stem mortality than Douglas-fir in the same wildfire? To make the comparisons simple, assume that all trees are located in a mixed oak-fir stand with relatively homogeneous site conditions and that all trees experience the same flame lengths.

	More Likely	Equally Likely	Less Likely
Sapling size class (DBH = 1-5")	○	○	○
Pole size class (DBH = 5-10")	○	○	○
Small size class (DBH = 10-20")	○	○	○
Large size class (DBH >20")	○	○	○

Please give a brief explanation of why you selected the answers you did:

4) In your best judgement, is a crown fire (active crowning or individual tree torching) in an oak stand more, less, or about equally likely as in a Douglas-fir under the same fire weather conditions and given similar stand structure (e.g., canopy cover and tree diameter sizes)?

- ○ Much more likely than in a comparable Douglas-fir stand
- ○ Somewhat more likely than in a comparable Douglas-fir stand
- ○ About the same likelihood as in a comparable Douglas-fir stand
- ○ Somewhat less likely than in a comparable Douglas-fir stand
- ○ Much less likely than in a comparable Douglas-fir stand

Please give a brief explanation of why you selected the answer you did:

Fire Behavior and Effects Under Extreme Fire Weather

We would like your best judgment about fire behavior in selected current and potential future vegetation types in the southern Willamette Valley foothills under extreme fire weather in both current and future climatic conditions. We are not asking you to predict future wildfire behavior, but rather to use your best judgment to describe what you might expect to occur based on the "what if" scenario we outline below for one particular climate model that projects a relatively high degree of change in fire weather.

Extreme Fire Weather under Current and Projected Future Climate Conditions

The main extreme fire weather indicator we are using is the **Energy Release Component (ERC)**. ERC is an NFDRS (National Fire Danger Rating System) index related to how hot a fire could burn, and is a function of the fuel model and live and dead fuel moistures. ERC for fire weather comparisons uses a single, standardized fuel model (fuel model "G") so that changes in ERC reflect the influence of climate. ERC is directly related to the 24-hour, potential worst case within the flaming front at the head of a fire. A doubling of ERC means a doubling of energy or heat that will be released in a passing fire front. ERC is considered the best fire danger component for indicating the effects of intermediate to long-term drying on fire behavior.

Our estimates of current and future extreme fire weather are based on recent data from local RAWS stations and projections under a climate change model (Hadley model, A2 emissions scenario) that predicts more extreme conditions for the future. Under the Hadley A2 model, the 97th percentile ERC over the next 50 years is projected to average 40% higher than the current 97th percentile ERC. These projected ERCs for the southern Willamette Valley are much higher than southwest Oregon's current extreme fire weather and equal or surpass that of current extreme fire weather in hot, dry areas of northern California. Although these future projections for the Willamettte Valley include more extreme fire weather due to hotter and drier summers, it is also important to note that winters will be warmer and moister, thus continuing to produce abundant fuels.

In addition to representative photos and a brief description of each vegetation type, we also note the fuel model we selected as the best fit from Scott and Burghan's (2005) 44 standard fuel models, and provide a description of the typical surface fuels that we have observed in each vegetation type. **Please feel free to comment on our decisions or descriptions.**

Current 97th percentile fire weather conditions:
ERC = 56
Winds = 22 mph
Fuel Moistures = 5/6/10/35/82 (1hr/10hr/100hr/live herbaceous/live woody)

Projected future 97th percentile fire weather conditions over the next 50 years:
ERC = 78
Winds = 22 mph
Fuel Moistures = 3/4/7/30/61 (1hr/10hr/100hr/live herbaceous/live woody)

Oak Savanna



Vegetation and Fuels Characteristics

Dominant species = Oregon White Oak
Canopy cover = <25%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: GR4 (104). Moderately coarse continuous grass, average depth about 2 feet.

Using the photo examples and your knowledge of oak savannas in the Willamette Valley or similar conditions, please answer the following questions.

5) For the oak savanna vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

6) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the oak savanna vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Oak Woodland



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Oregon White Oak
Canopy cover = >40%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: TU2 (162). Fuelbed is moderate litter load with moderate to high shrub and grass/herb component.

Using the photo examples and your knowledge of oak woodlands in the Willamette Valley or similar conditions, please answer the following questions.

7) For the oak woodland vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

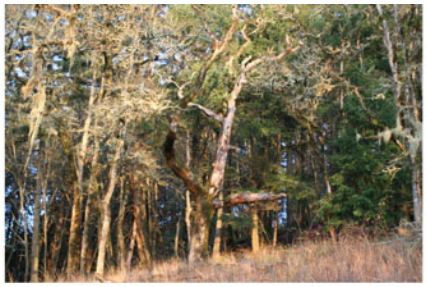
	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

8) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the oak woodland vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Mixed Douglas-fir/Oak Forest


Vegetation and Fuels Characteristics for Example Stand

Dominant species = Oregon White Oak and Douglas-fir, with younger Douglas-fir overtopping formerly dominant oaks
Canopy cover = >60%

Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: TU2 (162). Fuelbed is moderate litter load with moderate to high shrub and grass/herb component. Can contain substantial ladder fuels.

Using the photo examples and your knowledge of mixed Douglas-fir/Oak forests in the Willamette Valley or similar conditions, please answer the following questions.

9) For the mixed Douglas-fir/Oak forest vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

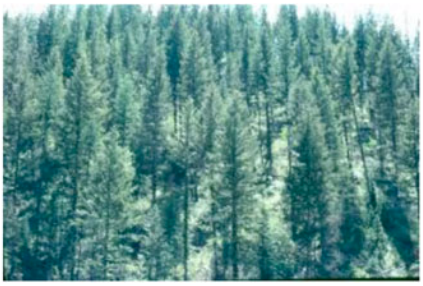
	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

10) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the mixed Douglas-fir/Oak forest vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Open Douglas-fir Woodland


Vegetation and Fuels Characteristics for Example Stand

Dominant species = Douglas-fir
Canopy cover = 25-60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: GS2 (122). The primary carrier of fire is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate.

Using the photo examples and your knowledge of open Douglas-fir woodlands in the Willamette Valley or similar conditions, please answer the following questions.

11) For the open Douglas-fir woodland vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

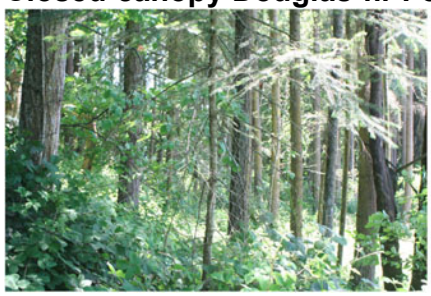
	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

12) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the open Douglas-fir woodland vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Closed-canopy Douglas-fir Forest



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Douglas-fir
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: TU1 (161). Generally moderate fuel loads. The primary carrier of fire is conifer and shrub litter, plus a substantial herbaceous component. May contain moderate to substantial ladder fuels.

Using the photo examples and your knowledge of closed-canopy Douglas-fir forests in the Willamette Valley or similar conditions, please answer the following questions.

13) For the closed-canopy Douglas-fir forest vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

14) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the closed-canopy Douglas-fir forest vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Ponderosa Pine Savanna

Vegetation and Fuels Characteristics for Example Stand

Dominant species = Ponderosa Pine
Canopy cover = <40%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: GR4 (104). Moderately coarse continuous grass, average depth about 2 feet.

Using the photo examples and your knowledge of Ponderosa Pine savannas in the Willamette Valley or similar conditions, please answer the following questions.

15) For the Ponderosa Pine savanna vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

16) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the Ponderosa Pine savanna vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Ponderosa Pine Woodland **(potential future vegetation type)**



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Ponderosa Pine
Canopy cover = >40%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: TL8 (188). Moderately high to high fuel loads. The primary carrier of fire is moderate load long-needle pine litter, shrub litter, and herbaceous fuels.

Using the photo examples and your knowledge of Ponderosa Pine woodlands in the Willamette Valley or similar conditions, please answer the following questions.

17) For the Ponderosa Pine woodland vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

18) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the Ponderosa Pine woodland vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Bigleaf Maple Forest



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Bigleaf Maple
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: SH2 (142). Moderate to high fuel loads. The primary carrier of fire is woody shrubs, shrub litter and a moderate herbaceous load.

Using the photo examples and your knowledge of maple forests in the Willamette Valley or similar conditions, please answer the following questions.

19) For the Bigleaf Maple forest vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

20) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the Bigleaf Maple forest vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Pacific Madrone Forest **(potential future vegetation type)**



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Pacific Madrone
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: SH2 (142). Generally moderate fuel loads. The primary carrier of fire is woody shrubs, shrub litter, and some herbaceous fuels.

Using the photo examples and your knowledge of Pacific Madrone forests in the Willamette Valley, please answer the following questions.

21) For the Pacific Madrone forest vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Active crown fire	0 %	0 %
Torching of individual canopy layer trees and surface fire only	0 %	0 %
Surface fire only	0 %	0 %
Total	0 %	0 %

22) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the Pacific Madrone forest vegetation type under extreme fire weather?

	Current Climate (97th Percentile ERC=56)	Future Climate (97th Percentile ERC=78)
Stand replacing fire	○	○
Mixed severity fire	○	○
Low severity fire	○	○

Please add any brief comments that help explain your answers:

Fire Effects by Flame Length and Tree Size Class

For our last set of questions, we want to explore fire effects in different vegetation types in a very different way. Please share your experience and best judgment about aboveground stem mortality for different tree species and sizes under different flame lengths.

Please keep in mind that we are seeking your expert judgement about flame length thresholds for aboveground mortality of different species and diameters of trees in different vegetation types. For each of the following types, please provide your assessment of whether the flame length thresholds for each diameter class of tree is too high, too low or about right. Many factors other than flame length may affect mortality, but please use your judgment to help us consider the effects of changes in this particular factor, using the photos and descriptions to guide your considerations.

Oak Savanna



Vegetation and Fuels Characteristics

Dominant species = Oregon White Oak
Canopy cover = <25%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: GR4 (104). Moderately coarse continuous grass, average depth about 2 feet.

Using the photo examples and your knowledge of oak savannas in the Willamette Valley or similar conditions, please answer the following questions.

23) For an oak savanna that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **2.5 feet**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **4.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **9.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **12.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Oak Woodland



Vegetation and Fuels Characteristics for Example Stand:

Dominant species = Oregon White Oak
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: TU2 (162). Fuelbed is moderate litter load with moderate to high shrub and grass/herb component.

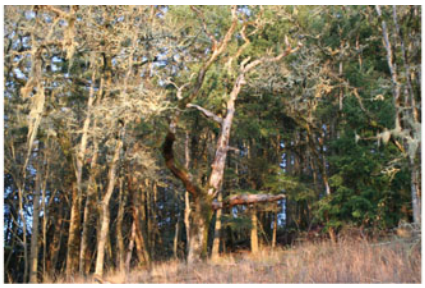
Using the photo examples and your knowledge of oak woodlands in the Willamette Valley or similar conditions, please answer the following questions.

24) For an oak woodland that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **2.5 feet**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **3.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **6.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **9.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Mixed Douglas-fir/Oak Forest


Vegetation and Fuels Characteristics for Example Stand:

Dominant species = Oregon White Oak and Douglas-fir, with younger Douglas-fir overtopping formerly dominant oaks
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: GS2 (122). The primary carrier of fire is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate.

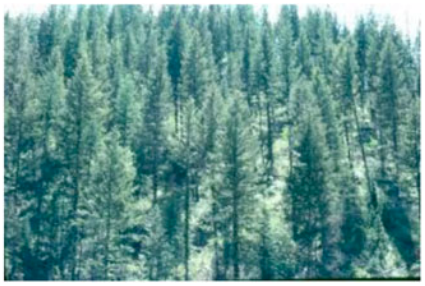
Using the photo examples and your knowledge of mixed Douglas-fir/Oak forests in the Willamette Valley or similar conditions, please answer the following questions.

25) For a mixed Douglas-fir/Oak forest that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **1.5 feet**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **2.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **3.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **4.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Open Douglas-fir Woodland


Vegetation and Fuels Characteristics for Example Stand:

Dominant species = Douglas-fir
Canopy cover = 25-60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: GS2 (122). The primary carrier of fire is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate.

Using the photo examples and your knowledge of open Douglas-fir woodlands in the Willamette Valley or similar conditions, please answer the following questions.

26) For an open Douglas-fir woodland that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **2.5 feet**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **4.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **7.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **12.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Closed Douglas-fir Forest

Vegetation and Fuels Characteristics for Example Stand

Dominant species = Douglas-fir
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: TU1 (161). Generally moderate fuel loads. The primary carrier of fire is conifer and shrub litter, plus a substantial herbaceous component. May contain moderate to substantial ladder fuels.

Using the photo examples and your knowledge of closed Douglas-fir forests in the Willamette Valley or similar conditions, please answer the following questions.

27) For a closed Douglas-fir forest that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **1.5 feet**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **2.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **4.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **6.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Ponderosa Pine Savanna



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Ponderosa Pine
Canopy cover = <40%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: GR4 (104). Moderately coarse continuous grass, average depth about 2 feet.

Using the photo examples and your knowledge of Ponderosa Pine savannas in the Willamette Valley or similar conditions, please answer the following questions.

28) For a Ponderosa Pine savanna that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **2.5 feet**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **5.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **9.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **15.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Ponderosa Pine Woodland **(potential future vegetation type)**



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Ponderosa Pine
Canopy cover = >40%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: TL8 (188). Moderately high to high fuel loads. The primary carrier of fire is moderate load long-needle pine litter, shrub litter, and herbaceous fuels.

Using the photo examples and your knowledge of Ponderosa Pine woodlands in the Willamette Valley or similar conditions, please answer the following questions.

29) For a Ponderosa Pine woodland that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **2.5 feet**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **3.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **4.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **6.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Bigleaf Maple Forest



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Bigleaf Maple
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: SH2 (142). Moderate to high fuel loads. The primary carrier of fire is woody shrubs, shrub litter and a moderate herbaceous load.

Using the photo examples and your knowledge of Bigleaf Maple forests in the Willamette Valley or similar conditions, please answer the following questions.

30) For a Bigleaf Maple forest that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **any flame**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **1 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **2 feet**	○	○	○	

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Large size class: **DBH = >20"** Flame Length: **3 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Pacific Madrone Forest **(potential future vegetation type)**



Vegetation and Fuels Characteristics for Example Stand

Dominant species = Pacific Madrone
Canopy cover = >60%
Tree size distribution: A broad range of tree diameters with some trees larger than 20" DBH
Fuel Model: SH2 (142). Generally moderate fuel loads. The primary carrier of fire is woody shrubs, shrub litter, and some herbaceous fuels.

Using the photo examples and your knowledge of Pacific Madrone forests in the Willamette Valley, please answer the following questions.

31) For a Pacific Madrone forest that contains the following tree diameter sizes, are the given flame lengths thresholds too high, too low, or about right to cause 50% or greater aboveground tree mortality in each DBH size class?

	Is this flame length threshold too high, low, or about right to cause 50% tree mortality?			If not about right, what flame length would you say 50% mortality would occur?
	High	Low	About right	Flame length (feet)
Sapling size class: **DBH = 1-5"** Flame Length: **any flame**	○	○	○	
Pole size class: **DBH = 5-10"** Flame Length: **1.5 feet**	○	○	○	
Small size class: **DBH = 10-20"** Flame Length: **2.5 feet**	○	○	○	
Large size class: **DBH = >20"** Flame Length: **3.5 feet**	○	○	○	

Please add any brief comments that help explain your answers:

Thank you for completing this questionnaire. We would appreciate it if you would enter your email address below. Entering your email address is optional, but will allow us to contact you should we need to follow up with you to better understand your responses. Your responses will remain anonymous and your email address will be deleted once we finalize the dataset.

Click next to finalize your questionnaire.

Email Address

Fire Behavior and Effects under Current and Future Climate: The Southern Willamette Valley Floor and Foothills

A research survey conducted jointly by the UO, OSU, and USFS with support from the National Science Foundation

Summary Report

This survey was conducted between May 10 and June 5, 2012 using Qualtric online survey research software through the University of Oregon. We invited a total of 17 wildfire managers to participate in the survey. Invitees were purposively selected from various state and federal agencies for their potential knowledge about wildfire behavior and effects in oaks vegetation types in western Oregon. 13 invitees viewed the survey, 10 provided some responses and 7 completed at least 50% of the survey. Most respondents spent about an hour completing the survey. The majority of the missing data in the survey was generated in the third and final section of the survey, which focused on fire effects. The survey can be viewed online at:

https://oregon.qualtrics.com/SE/?SID=SV_6SiW2CSyOZN6hgg

Key Points

1. Open stand suffer lower mortality rates than closed stands
2. Multi-layer stands can experience greater mortality than single-layer stands
3. Oaks may be somewhat less susceptible to aboveground tree mortality than Douglas-fir at smaller size classes, but equally susceptible at larger size classes (however, written comments seems to contradict the above).
4. Crown fire in oak stands seems to be less likely than in Douglas-fir stands, although some disagreement. Comments to the contrary reflect complexity of the simple question.
5. Active crowning is least expected in oak savanna, open Doug-fir woodland, pine savanna, and bigleaf maple stands (<15% of the time). Torching or surface fire are the most common fire behaviors expected. And surface fire is the most common expectation for oak and pine savannas.
6. Fire behavior in the future is generally expected to shift towards the more extreme.
7. Generally, the fire effects thresholds we gave were judged to be about right by most respondents, although typically 1 to 2 respondents suggested otherwise. The exception was for the mixed Douglas-fir and open Douglas-fir types; respondents showed more diversity of opinions for these types

Last Modified: 06/12/2012

Max Nielsen-Pincus

1) How might the effects of a surface fire differ among the following two types of forest stands if the flame lengths were the same? Assume the two forest types have similar tree species and diameter distributions. (Please check the answer you feel is most accurate)

a. Forest stand A has an open canopy, sparse trees and a high level of herbaceous fuels (leading to a faster rate of spread and shorter residence time).

b. Forest stand B has a closed canopy, more trees and more woody ground fuels (leading to a slower rate of spread and longer residence time).

#	Answer		Response	%
1	Forest stand A would suffer lower tree mortality rates than forest stand B		9	100%
2	Forest stand A would suffer tree higher mortality rates than forest stand B		0	0%
3	There would be no difference in tree mortality rates between forest stand A and forest stand B		0	0%
	Total		9	100%

Please give a brief explanation of why you selected the answer you did:

Text Response
Open canopy with a large amount of herbaceous fuels would lead to a rapidly spreading fire. Though the flame lenghts may be higher than Forest stand B, the quickly moving fire does not put as much heat on the trees as a slower moving fire. We have burned 80-90% of the crown off of medium sized Oaks and they have not been affected and produced full canopy of leaves the following spring.
Most tree species found in the Willamette Valley have relatively thick bark, especially near the soil surface. The bark of oaks and other hardwoods are non-resinous as well, increasing their fire resistance. Short, fast-moving flames with faster burnout times produce less total heat than short, slow-moving flames with slower burnout times, resulting in a lower heat pulse into bark, even thin bark, and soils.
This would all depend on the age of the stand and species. Young short trees with low Crown base height would have similar mortality in each case
Total energy production will be much higher for the same flame length but greater residence time, and with heat trapping under a closed canopy, and will increase mortality.
flame length the same but intensity higher in stand B do to more woody ground fuels etc... open canopy A would have light flashy grasses etc... not killing the trees vs. longer duration "cooking" time on the trees in B
It depends on the species receiving the fire, bark thickness. Generally longer fire means more heat and likelihood of damage.
Open canopy and fine fuels allow for the fire to move through the stand quickly. Less heavy fuel on the ground reduces the intensity of the fire.
The shorter residence time and more open canopy will lessen mortality rates.
Given the types of fuels on the ground and the residence time of fire stand b being longer, the mortality may increase on stand b. Seems the type of trees would make a difference when looking at mortality, but the heat/unit area should be higher in stand b. I am thinking of DF, not oak.

2) How much do you agree or disagree with the following statement?

For a surface fire at a given flame length and all else being equal, a mutli-layer stand with a mixture of large diameter trees and smaller diameter trees will experience greater tree mortality

rates than a one-layer stand with only larger diameter trees. (Please select one answer)

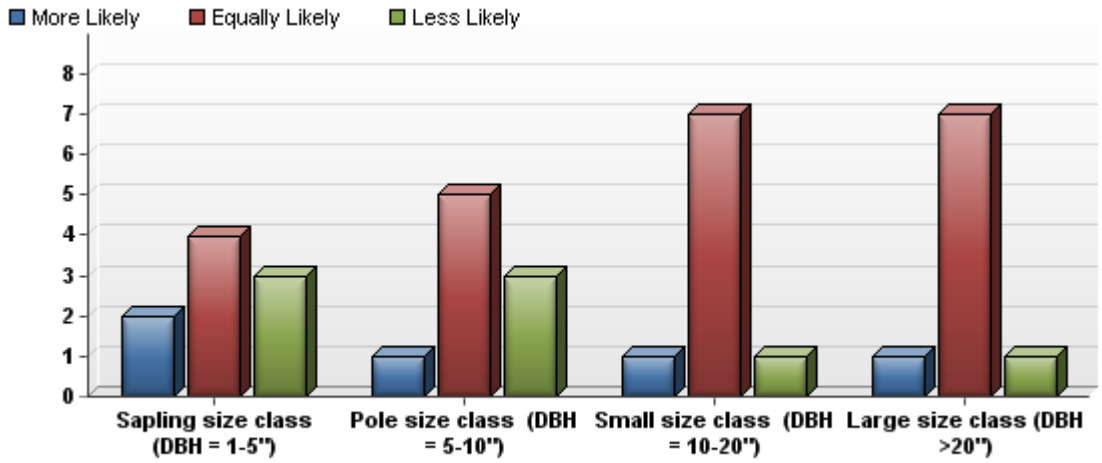
#	Answer		Response	%
1	Completely agree		2	22%
2	Somewhat agree		6	67%
3	Neither agree nor disagree		1	11%
4	Somewhat disagree		0	0%
5	Completely disagree		0	0%
	Total		9	100%

Please give a brief explanation of why you selected the answer you did:

Text Response
Smzzller diameter trees are less fire resistant than older more mature oaks.
It's likely more true than not, but whether a surface fire causes greater mortality in a multi-layer stand than a single layer stand depends somewhat on the burnout time (fire duration). For example, a single-layer ponderosa pine stand may experience similar mortality as a multi-layer stand of ponderosa pine if both stands are characterized by deep duff layers that are dry, especially around the larger diameter trees. I have seen times when it was the large trees that died and the small trees that survived in a multi-layered ponderosa pine stand due to prolonged smoldering in heavy accumulations of bark flakes and needles around the bases of the large trees. Such accumulations can also hide small rot pockets at the surface that allows fire to get into the interior of the tree and burn out the middle until the tree falls, yet the crown is still green.
Depends on age and species. A sub-Alpine fir stand could be large, one-layered and have very high mortality.
It depends on where the one layer is in relation to the heat - it might all go up or might all be safe, whereas the multiple layers will have some mortality and some survival scattered all around under a range of conditions.
higher mortality of the small and suppressed trees (including small seedlings that only a few feet tall etc...)
Multi layer stand with small trees coudl have more mortality becasue small trees with thinner bark are not as resistant to heat.
Given the same number of trees in each scenario the stand with more small diameter trees will experience more mortality.
Greater tree mortality would come from trees that are shade tolerant and do not have the characteristics to withstand fire. However, if it is just a surface fire and the ground fuels are the same, mortality might not be too different. This seems difficult given the range of FL determined.

3) For the following diameter size classes, is Oregon white oak more, equally, or less likely to suffer aboveground stem mortality than Douglas-fir in the same wildfire? To make the comparisons simple, assume that all trees are located in a mixed oak-fir stand with

relatively homogeneous site conditions and that all trees experience the same flame lengths.



#	Question	Mean
1	Sapling size class (DBH = 1-5")	2.11
2	Pole size class (DBH = 5-10")	2.22
3	Small size class (DBH = 10-20")	2.00
4	Large size class (DBH >20")	2.00

Please give a brief explanation of why you selected the answers you did:

Text Response
In my experience, smaller sized oaks (sapling and pole sized) are just as susceptible to mortality as Douglas-fir. As the oaks mature they become less likely to be killed by fire whereas the Douglas-fir will still be susceptible to mortality if the crown is scorched or burned completely.
Oak bark is non-resinous while Douglas-fir bark is. The lack of resin and the "corky" nature of oak bark means it's thinner bark functions much the same as the thicker Douglas-fir bark. In addition, Oregon white oaks do not carry fire through their crowns due to the chemical composition of their leaves (few to no volatiles). While the current crop of leaves can be killed, that doesn't necessarily translate into above-ground death of the tree in Oregon white oak, unlike in Douglas-fir. Like many in the white oak group, dead Oregon white oak leaves are often not that flammable either since they tend to lie flat and not curl, unlike typical leaves in the red oak group. That keeps the leaves in fuller contact with the ground and hence wetter and with a less optimum packing ratio for promoting fire spread and greater flame lengths. Most differences in mortality of Douglas-fir verses Oregon white oak tend to emerge as flame length and fire duration increase.
Not sure - My guess based on the few old stands of White oak and doug fir I have seen they self thinned (probably by fire) at similar size classes - probably the sapling and pole. This is based on these older stands had similar spacing for all the trees and I guess similar aged White Oak and Doug fir. In the stands that have not seen fire I have seen the old Doug fir still present but the White Oaks are skeletons because the young Doug fir have grown up around the Oak tree.
I think of them as the same UNTIL Douglas-fir gets large with thicker bark.
smaller trees hard to tell depending on the size range. some of the really small trees probably equal but as the Oak gains some size, i think the DF will be impacted more than the Oak would from what i have observed in the field with low intensity fire/burns.
It is not just about size (DBH) of trees. Some DF can be small in diameter but have developed thicker bark and then be more resistant. Not sure if your question is trying to get at what people think or what is real. The fire effects studies should be able to provide more definitive answers
Eventually the taller height of same diameter DF will be a factor in reducing scorch and mortality. Also, the larger DF should have more bark thickness to be fire resilient like oak.
I do not feel very knowledgeable about answering this question. I don't have enough research done on oak ... soon though:-)

4) In your best judgment, is a crown fire (active crowning or individual tree torching) in an oak stand more, less, or about equally likely as in

a Douglas-fir under the same fire weather conditions and given similar stand structure (e.g., canopy cover and tree diameter sizes)?

#	Answer		Response	%
1	Much more likely than in a comparable Douglas-fir stand		0	0%
2	Somewhat more likely than in a comparable Douglas-fir stand		3	33%
3	About the same likelihood as in a comparable Douglas-fir stand		0	0%
4	Somewhat less likely than in a comparable Douglas-fir stand		2	22%
5	Much less likely than in a comparable Douglas-fir stand		4	44%
	Total		9	100%

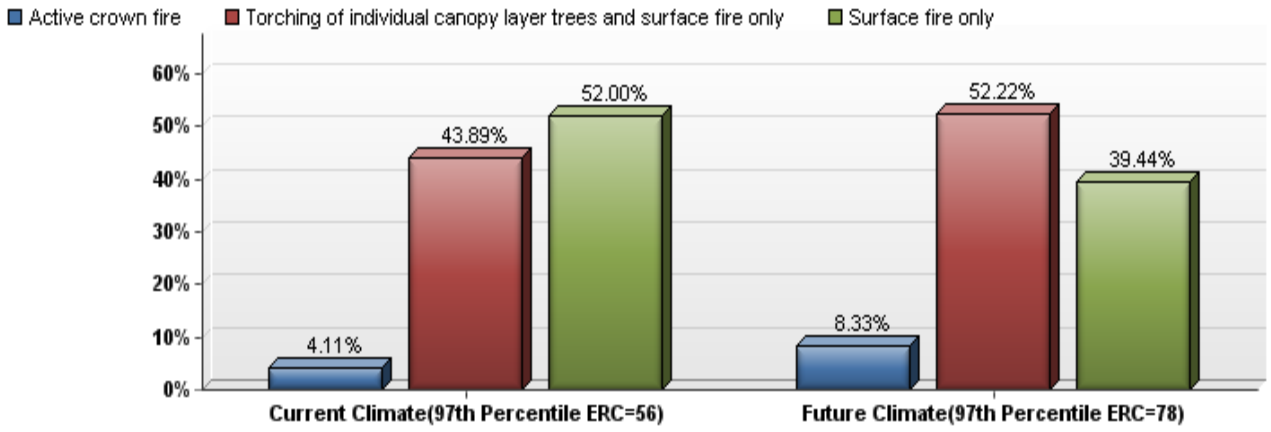
Please give a brief explanation of why you selected the answer you did:

Text Response
Difficult question to answer due to the number of variables involved. The presence of ladder fuels, seasonality etc etc. In the late fall with the presence of lichen and the oak leaves beginning to cure and fall, a crown fire would be more likely in a oak stand than a Douglas-fir stand.
The chemical composition of Oregon white oak leaves do not promote active crowning unless the leaves are dead but still attached. Even then, the size and shape of the leaves (essentially, the surface area to volume ratio) does not promote active crowning. Just as crown fires do not occur in eastern hardwoods, crown fires basically do not occur in Oregon white oak stands and for the same reasons. While flames can reach into the crowns of Oregon white oak, the resulting heat is more likely to result in scorch damage instead of torching and crowning.
Unless the stand is over grown with conifer encroachment
I think the moisture content and arrangement and volatility of the foliage make oak less flammable, but it might just be less fuel of the surface below them (relative to DF).
There are so many variables that play into these scenarios. Oaks have a more open canopy and would be harder to carry fire except they are more loaded with moss on the limbs and lichen (old mans beard) hanging from limbs etc... I have observed fire carry thru oaks with these conditions where as less with the DF but they have less. On the Clark Fire in Fall Creek back approx 2003 there was crown fire and then when we went to do a burnout, could not get anything to burn even the old mans beard until the correct humidity... in an Oak the open canopy allows the moss and lichens to dry more and more readily accessible to burn unlike a DF canopy area with higher RH and shaded...
the small needle size of fir allows the fire to catch and spread more easily than oak leaves. Also the DF usually has live crown a bit lower. more continuity of crown in DF than oak
Oak is much less flammable due to its chemical make-up than DF.
I am not sure about the oak. But off assumption I would guess the leaf litter or the leaves on the trees (given the state of dryness) would add to higher probability in a continuous canopy. If canopy is open I think it would be about the same between the two stands.

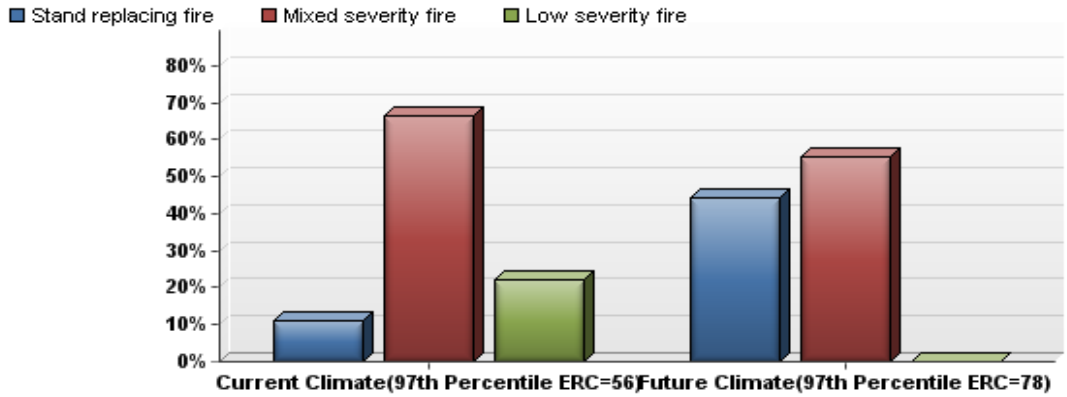
Part II. Fire Behavior

5) For the <u>oak savanna</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior

category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



6) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the oak savanna vegetation type under extreme fire weather?

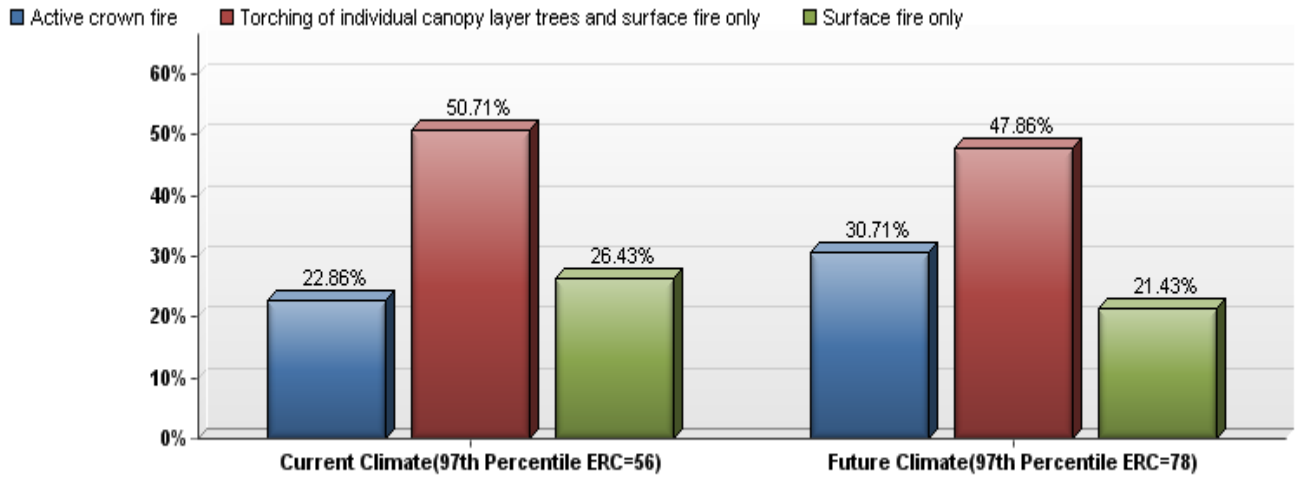


#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	1	6	2	2.11
2	Future Climate(97th Percentile ERC=78)	4	5	0	1.56

Please add any brief comments that help explain your answers:

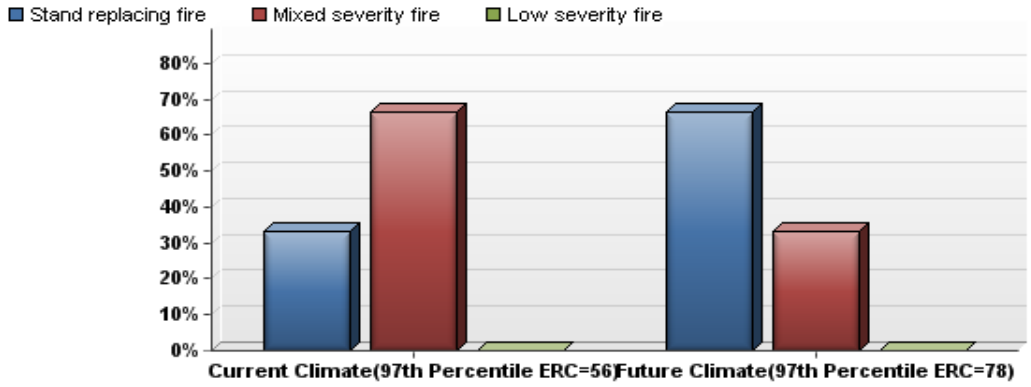
Text Response
Open canopy with little ladder fuels, this fuel type would most likely experience individual tree torching with isolated areas of active crown fire.
Oaks need summer moisture, which they currently receive, even if not a lot. Timing is more important than amount in that regard, but a minimum amount is necessary. It's unclear if the projected climate would even allow Oregon white oaks to persist in the Willamette Valley. In addition, a shift in the understory species composition is likely. Medusahead is surprisingly widespread in parts of the Willamette Valley. The projected climate in combination with the soils of the Willamette Valley and increasing nitrogen deposition from agriculture and vehicles is more likely to favor medusahead and other annual grasses over perennial grasses, changing the fire dynamics.
I do not expect much active crown fire becaused of the open canopy. But with a 22 mph wind most canopies will have fire in them.
Not that much difference relative to the variability out there in the fuels.
with grass carrying the fire I would think mortaltiy would always be low. I have not seen much mortality except when there is shrub or other fuels to carry the fire and increase residence time.
That combination of wind and fuel moisture would kill most vegetation species. In the case of oak it might respond from the root collar or lower stem the following year.
I don't feel confident answering these questions. They are assumptions of what I would imagine to see are based on burns in P-J and in shruby grasslands.

7) For the <u>oak woodland</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



8) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of

aboveground tree mortality would you expect to occur most often in the oak woodland vegetation type under extreme fire weather?

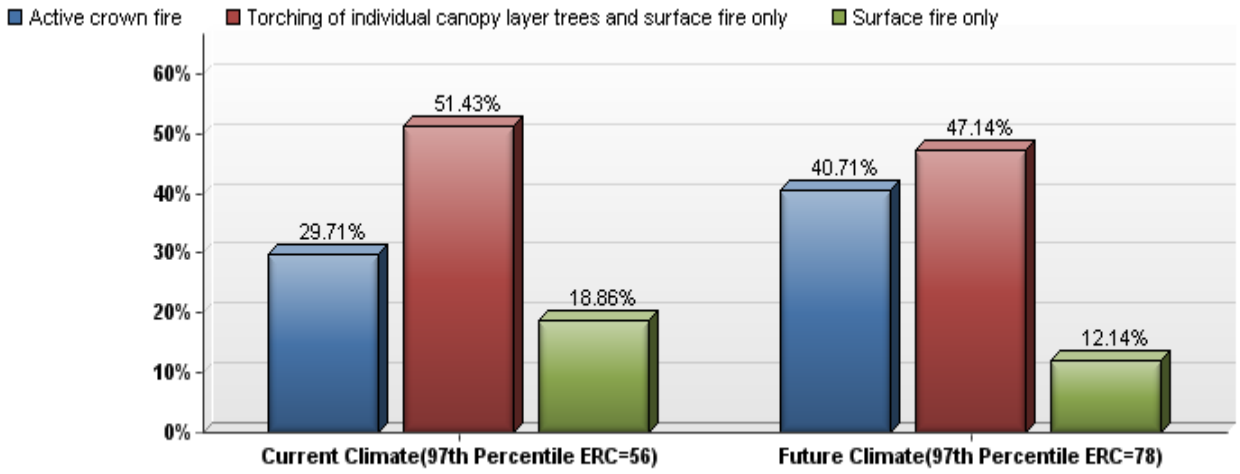


#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	2	4	0	1.67
2	Future Climate(97th Percentile ERC=78)	4	2	0	1.33

Please add any brief comments that help explain your answers:

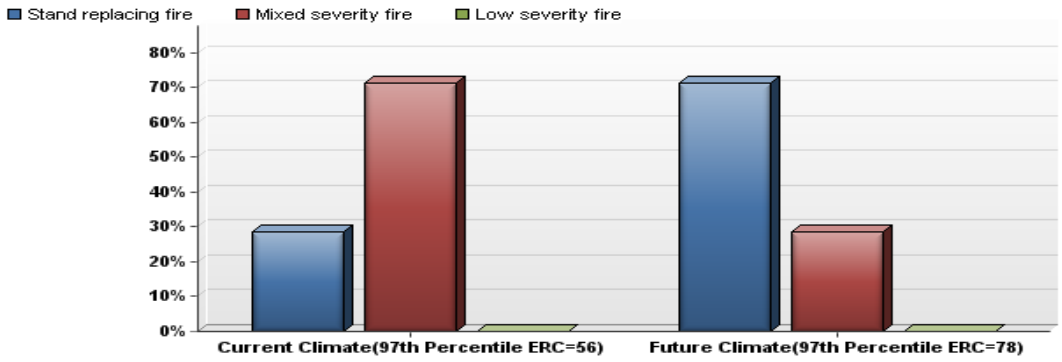
Text Response
Closed canopy with large concentration of ladder fuels would most likely result in an active crown fire under given conditions.
As my answer above, it's unclear if Oregon white oak will continue to persist in the future climate although savannahs are more likely to persist than woodlands due to reduced demand for soil water in the summer. The high shrub component is the greater problem with respect to fire behavior than the oaks in the woodland examples above. Much would depend on the species composition of the shrub layer and whether those species contain a higher proportion of volatiles in their leaves or not (e.g. vine maple verses ceanothus or manzanita). Although the only option offered above is torching, instead, I think you would see more scorch of the overstory with a higher likelihood that the heat produced by a volatile shrub understory would be sufficient to kill more epicormic buds in the oaks, hence killing the trees.
It goes up under these conditions, period!
Ladder fuels, litter and woody loading under to support fire and extended duration, moss and lichen in hardwoods (oaks) etc..
Tree density and wind speed of 22 mph is very conducive to crown fire.
I have not seen this type of fuel model burning but I compare it to shruby fuels in mid and southern california.

9) For the <u>mixed Douglas-fir/Oak forest</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



10) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in

the mixed Douglas-fir/Oak forest vegetation type under extreme fire weather?

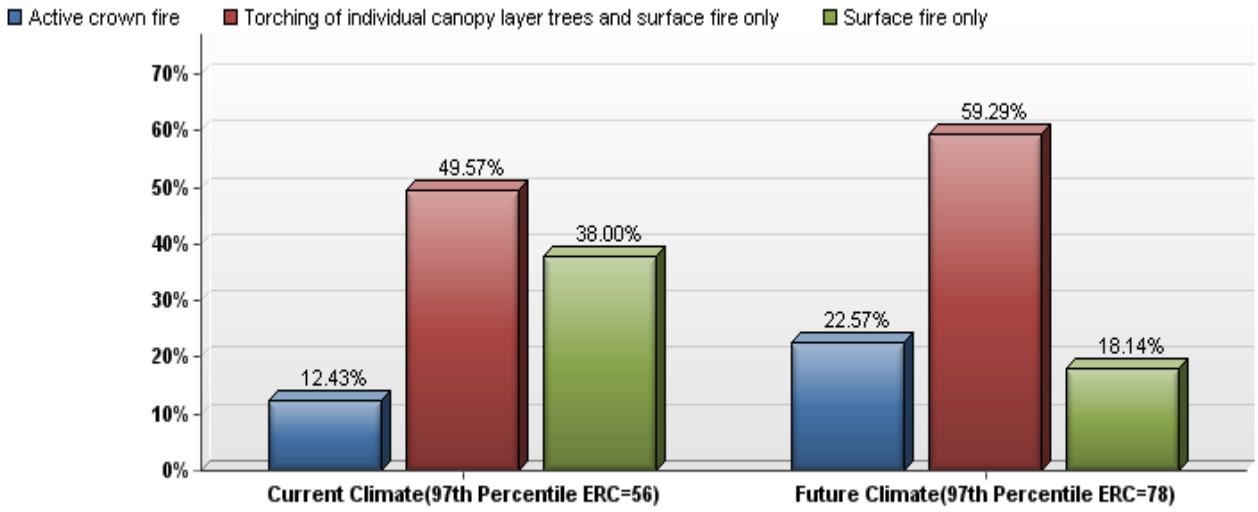


#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	2	5	0	1.71
2	Future Climate(97th Percentile ERC=78)	5	2	0	1.29

Please add any brief comments that help explain your answers:

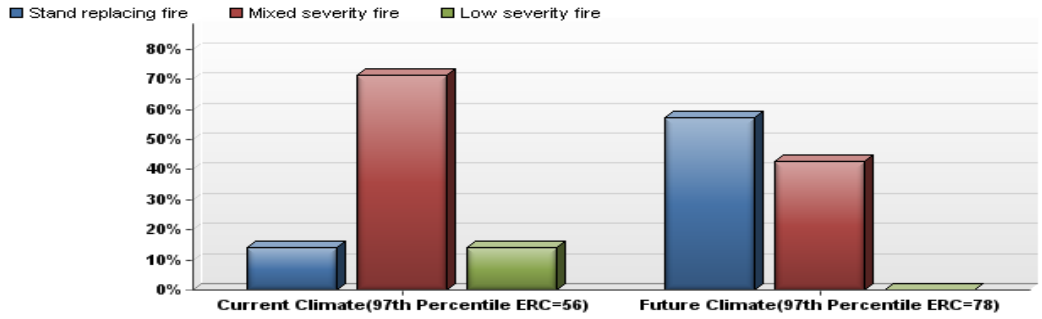
Text Response
Depending on seasonality and live fuel moisture in the ladder fuels, this fuel type would most likely experience an active crown fire under both ERC scenarios.
How much active crown fire might result depends on the proportion of Douglas-fir and Oregon white oak. The higher the proportion of Douglas-fir, the greater the likelihood of active crown fire and torching. The higher the proportion of Oregon white, the opposite is true. Future climate is more likely to favor Douglas-fir over Oregon white oak as Douglas-fir is more tolerant of summer drought.
Even more burnable.
Ladder fuels, mixed with Oaks having moss and lichens etc...

11) For the <u>open Douglas-fir woodland</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



12) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in

the open Douglas-fir woodland vegetation type under extreme fire weather?



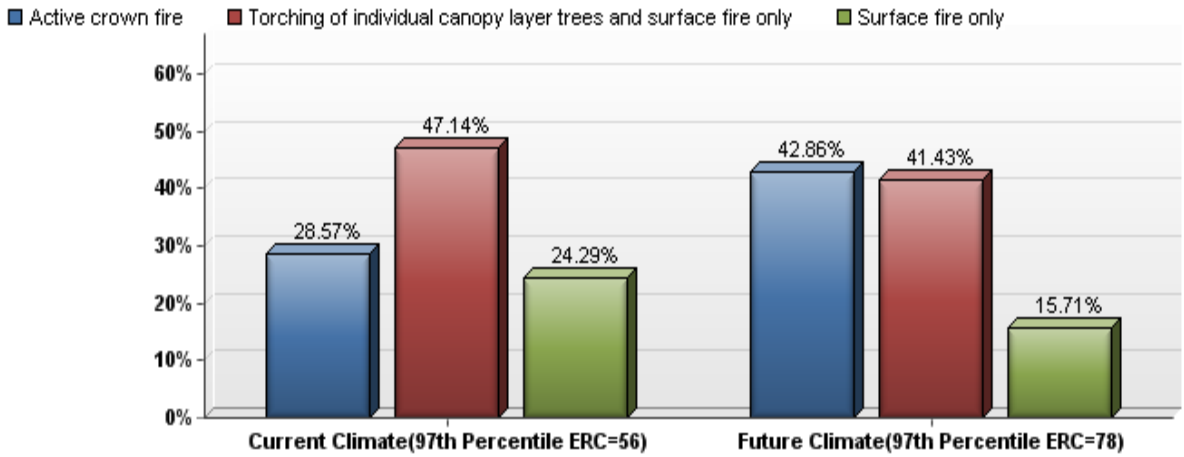
#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	1	5	1	2.00
2	Future Climate(97th Percentile ERC=78)	4	3	0	1.43

Please add any brief comments that help explain your answers:

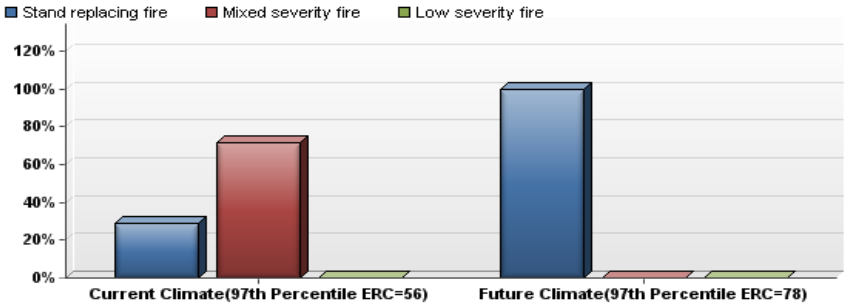
Text Response
Depending on vertical arrangement of fuels, even though it is an open canopy, this fuel type could experience an active crown fire under severe weather conditions.
Fuel arrangement in most open conifer woodlands tends to support more surface fire than crown fire. I assumed tree distribution was somewhat clumpy and those clumps would be more likely to torch and crown. Canopy bulk density is usually low enough to limit the amount of crown fire, but under extreme conditions, some active crowning is possible. In the future, likely the live fuel moistures will be lower due to increased summer drought and heat, increasing the probability of frequent torching, short crowning runs and active crown fire even under the lower canopy bulk densities of woodland.
grass and shrubs - lower number of ladder fuels, open DF more difficult to get into crown fire stage
With the 22 mph wind and the stands partially sheltered there is some potential for the fire to stay on the ground, especially if there are no ladder fuels to carry the fire upward.

13) For the <u>closed-canopy Douglas-fir forest</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior

category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



14) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the closed-canopy Douglas-fir forest vegetation type under extreme fire weather?



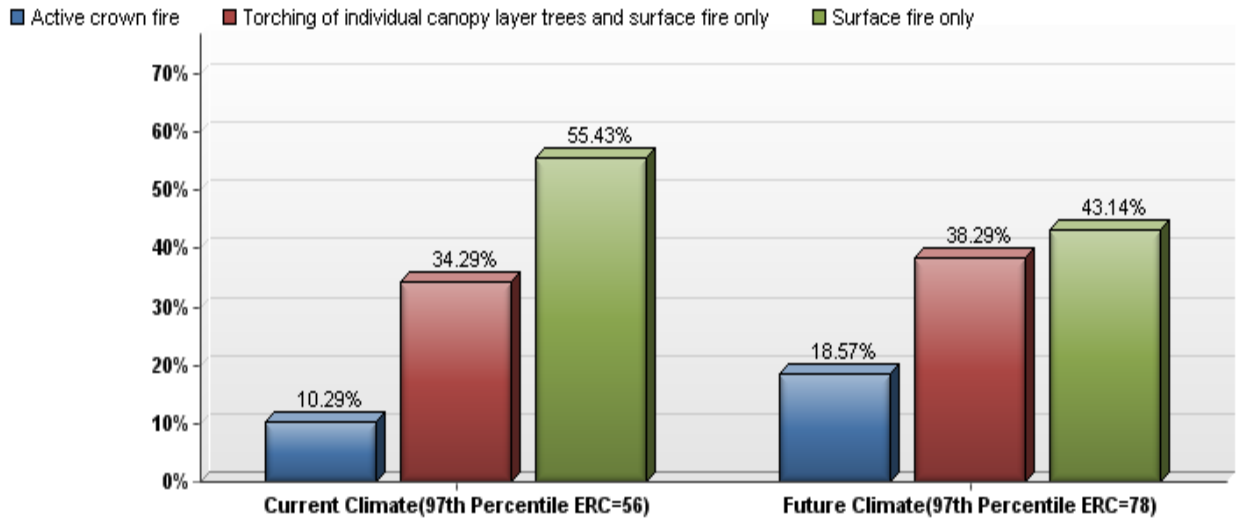
#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
2	Future Climate(97th Percentile ERC=78)	7	0	0	1.00
1	Current Climate(97th Percentile ERC=56)	2	5	0	1.71

Please add any brief comments that help explain your answers:

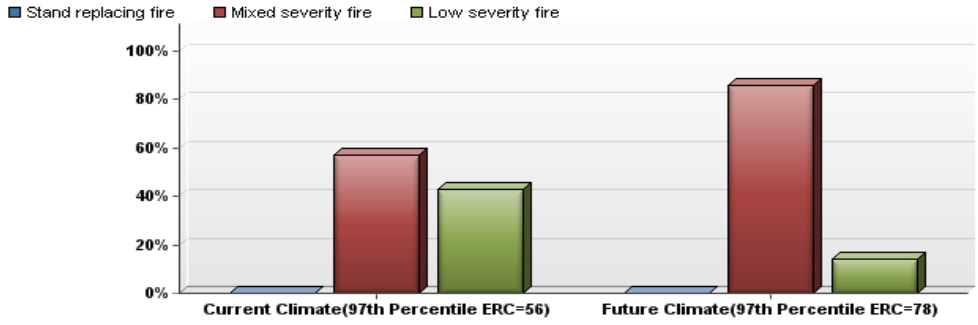
Text Response
Again, depending on seasonality and the live fuel moisture and vertical arrangement of ladder fuels, an active crown fire would be likely.
Most recent fires in Willamette Valley Douglas fir forests have been mixed severity. The conditions discussed under the woodland above are further exacerbated as canopy closure increases. It's unclear if closed canopy Douglas-fir forest will persist under the future climate at the lower elevations.
If it is an older stand with lots of licen and dead material in the canopy it would be high severity
ladder fuels, closed canopy higher RH,

15) For the Ponderosa Pine savanna vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior

category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



16) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the Ponderosa Pine savanna vegetation type under extreme fire weather?



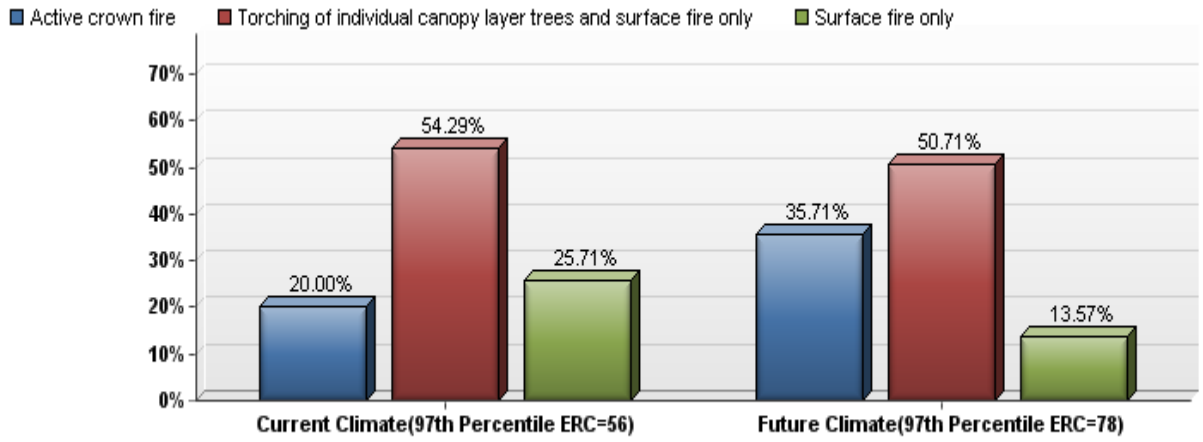
#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	0	4	3	2.43
2	Future Climate(97th Percentile ERC=78)	0	6	1	2.14

Please add any brief comments that help explain your answers:

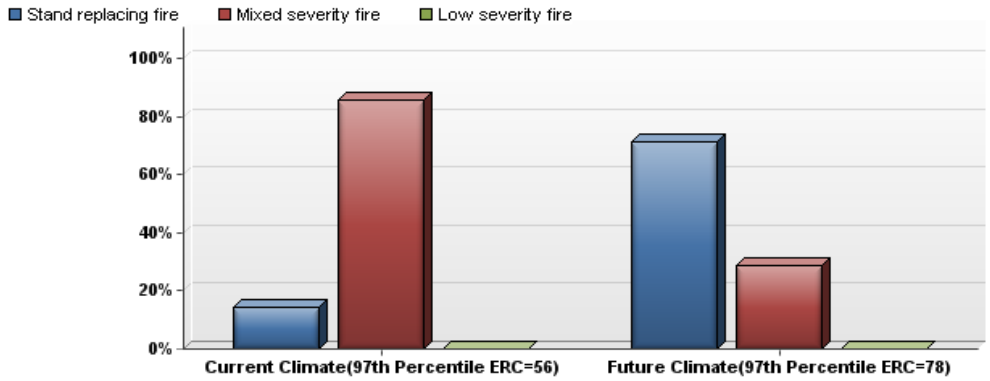
Text Response
Canopy bulk density in ponderosa pine savannah is usually too low to support more than occassional torching in denser clumps under current conditions. Lower live fuel moistures may increase the incidence of torching and short crowning runs in the future, assuming current savannah densities can persist. If savannahs become more open, then the relative proportion of active crown, passive crown and surface fire may change little from the present.
open underneath lack of ladder fuels pine stand

17) For the <u>Ponderosa Pine woodland</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior

category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



18) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the Ponderosa Pine woodland vegetation type under extreme fire weather?



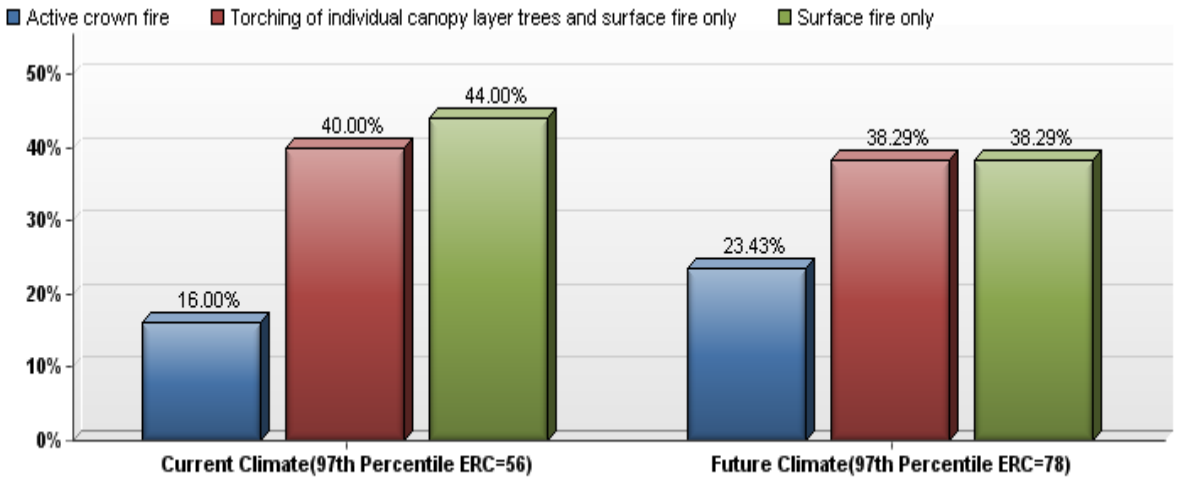
#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	1	6	0	1.86
2	Future Climate(97th Percentile ERC=78)	5	2	0	1.29

Please add any brief comments that help explain your answers:

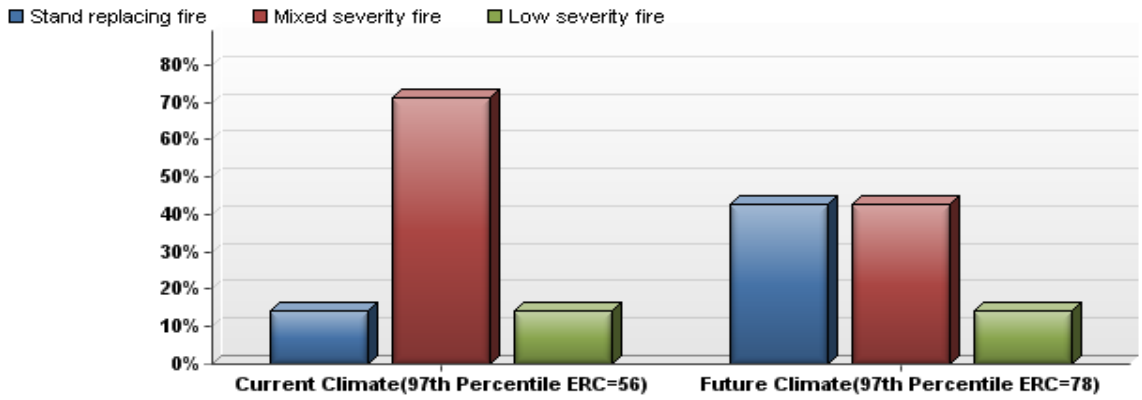
Text Response
Multi-story ponderosa pine woodlands have a higher proportion of torching and crowning than pine savannah, tending to result in a mixed severity regime. Under the future climate, I would expect less surface fire and more passive and active crown fire, potentially tipping these systems into stand-replacing, although the higher mortality is likely to come from increases in both the frequency of torching and active crown fire.
This one might be in that window where this increased ERC might flip the balance

19) For the <u>Bigleaf Maple forest</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior

category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



20) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in the Bigleaf Maple forest vegetation type under extreme fire weather?



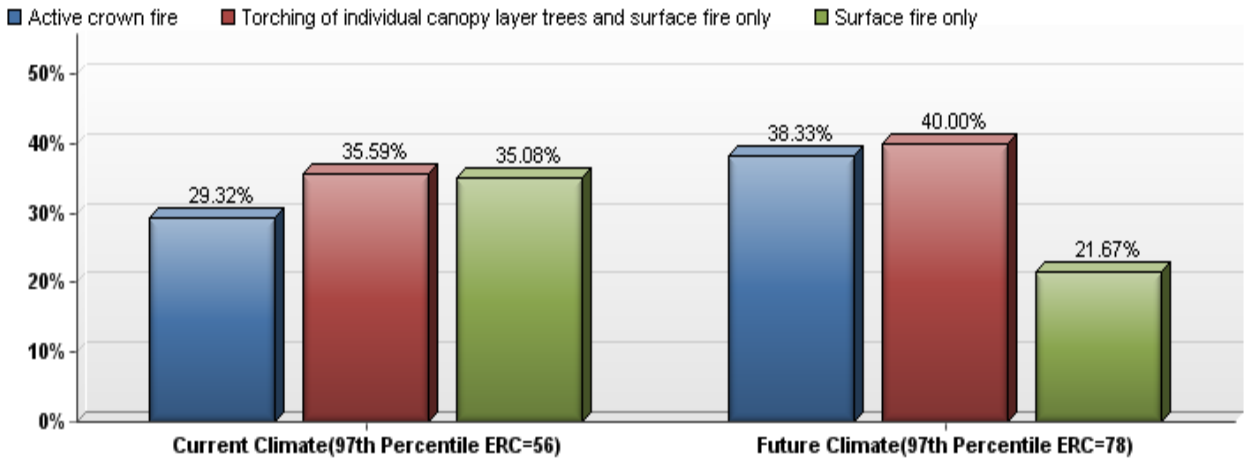
#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	1	5	1	2.00
2	Future Climate(97th Percentile ERC=78)	3	3	1	1.71

Please add any brief comments that help explain your answers:

Text Response
As with oaks, bigleaf maple leaf chemistry and canopy bulk density do not support crowning, however bigleaf maple has noncorky bark, making it susceptible to lethal underburning. Under future climate, I would expect bigleaf maple to shift upslope and the understory species composition could shift to support more grasses and fewer forbs. If that happens, then fires could occur more often, further reducing the extent of this type.
Seems like this situation is either on the surface or in the crowns.
burn the moss and lichens - higher RH and typically shading... fire carry thru moss
I am basing this on our prescribed fires where the intensity from the fire on the ground can easily burn leaves and shadded fuels given the low fuel moistures.

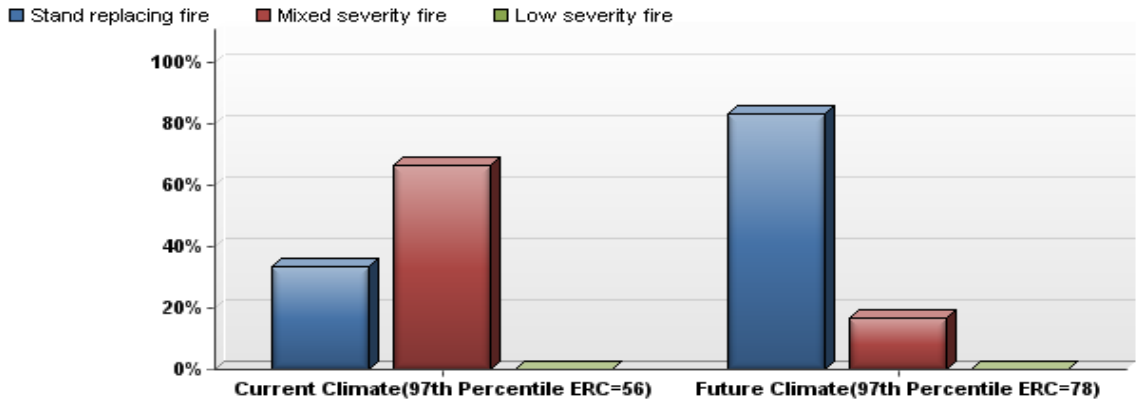
21) For the <u>Pacific Madrone forest</u> vegetation type given the above conditions, what percent of the time might you expect to see each of the following fire behaviors under extreme fire weather in the southern Willamette Valley foothills? (For each fire behavior

category, please enter a percentage between 0% and 100%, and make sure your total percentage adds to 100%. No ties, please.)



22) For the fire behavior category you considered most likely for extreme fire weather in the question above, what level of aboveground tree mortality would you expect to occur most often in

the Pacific Madrone forest vegetation type under extreme fire weather?



#	Question	Stand replacing fire	Mixed severity fire	Low severity fire	Mean
1	Current Climate(97th Percentile ERC=56)	2	4	0	1.67
2	Future Climate(97th Percentile ERC=78)	5	1	0	1.17

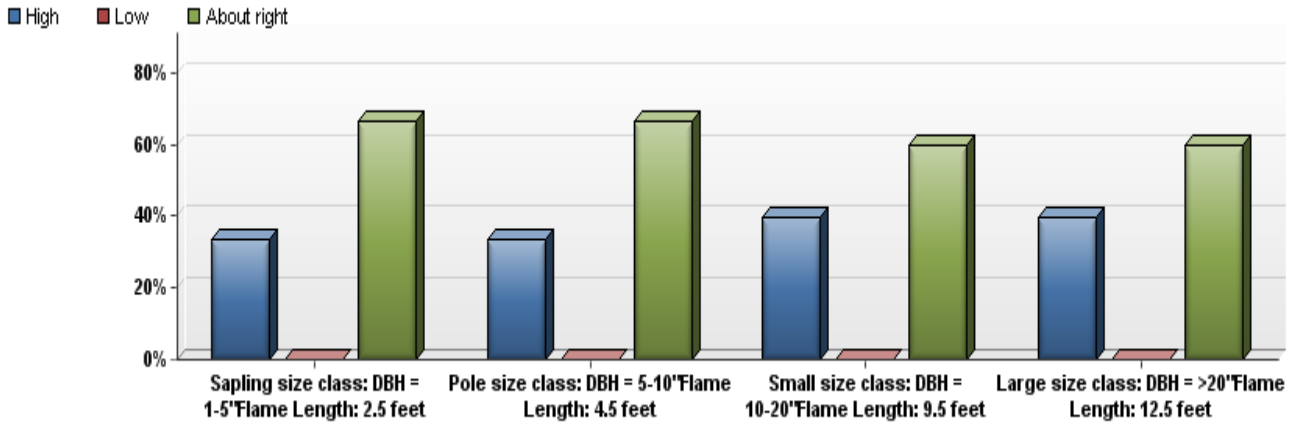
Please add any brief comments that help explain your answers:

Text Response
This is a tougher one as I am not as familiar with madrone. The leaves have more volatiles, increasing flammability, but are thick, which reduces flammability. The species is very thin barked, making it highly susceptible to lethal underburning, but also sprouts quite readily. Madrone is more tolerant of summer drought than species like maples. It could be that in the future, fire frequency reduces the proportion of tree-sized madrone and it becomes more of a shrub species in the understory of a conifer woodland or savannah.
Don't know that i have a great answer for anything on this page... all estimates and feelings at this time. if had time could possible run thru Behave etc... but sure you all can do and probably already have done this as well to get a better understanding.
Have not seen fire in madrone forests.

Fire Effects by Flame Length and Tree Size Class

23) OAK SAVANNA

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: 2.5 feet	2	0	4	0.33
3	Pole size class: DBH = 5-10" Flame Length: 4.5 feet	2	0	4	0.33
4	Small size class: DBH = 10-20" Flame Length: 9.5 feet	2	0	3	0.40
5	Large size class: DBH = >20" Flame Length: 12.5 feet	2	0	3	0.40

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: 2.5 feet
Flame length (feet)
1
1.5

Default - Pole size class: DBH = 5-10" Flame Length: 4.5 feet
Flame length (feet)
3
3.5

Default - Small size class: DBH = 10-20" Flame Length: 9.5 feet
Flame length (feet)
6
7.0

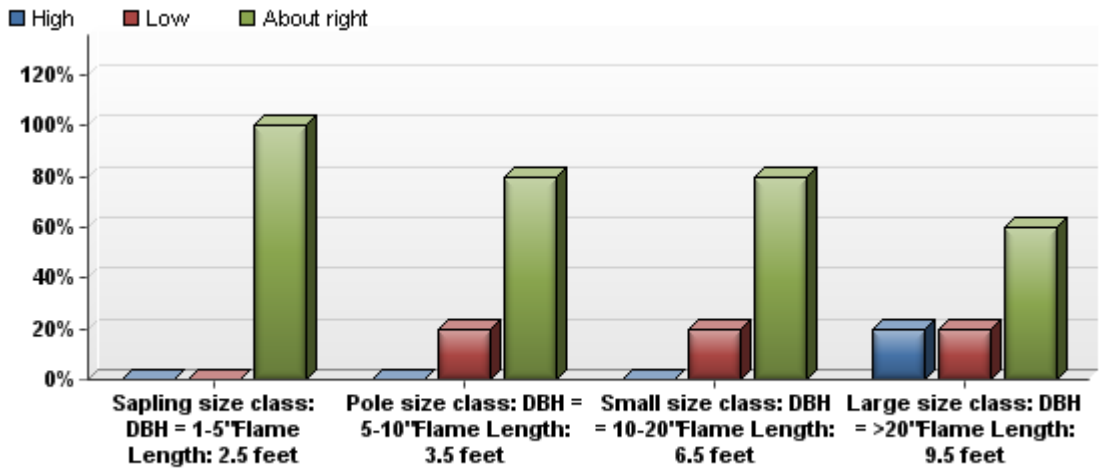
Default - Large size class: DBH = >20" Flame Length: 12.5 feet
Flame length (feet)
8
9

Please add any brief comments that help explain your answers:

Text Response
I don't really think that flame lenght contributes to mortality in the larger diameter trees. Duration of exposure to heat is more a factor in mortality. If there is dead and down (limbs) around the base of of a large oak, it is more likely to experience mortality regardless of scorch height.
Given their bark, leaf chemistry and structure, typical canopy bulk density. and epicormic buds, it issue is less about flame length and more about heat per unit area. Oaks are quite tough, but there is probably a threshold heat per unit area-fire duration combination that is lethal to the cambium of oaks. I don't know what that threshold might be.
and I don't think you can get those flame lengths anyway
guess work on these. it seems like when we have burned at Pisgah that more than 1.5ft or so take out younger (small trees) if in the open. when in more of a stand setting - probably 2.5 would be reasonable.
The way I am interpreting these questions is based not only on the individual tree but also the surrounding vegeation using the photos. It is hard for me to identify one single tree (except in #23 because of the type of stand and looking at tree canopy height). For the questions down below the crown continuity, the ladder fuel and the size of the trees all go into play. Additionally the type of tree given the bark and resilience to fire. But what I am unclear about is oak's ability to regenerate, resprout, bud again.... I thought they are intertwined with fire. Oaks that I've seen recover from fire the crowns are fully scorch and leaves consumed, yet the following year they return green and alive.

24) OAK WOODLAND

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: 2.5 feet	0	0	5	0.00
3	Pole size class: DBH = 5-10" Flame Length: 3.5 feet	0	1	4	-0.20
4	Small size class: DBH = 10-20" Flame Length: 6.5 feet	0	1	4	-0.20
5	Large size class: DBH = >20" Flame Length: 9.5 feet	1	1	3	0.00

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: 2.5 feet
Flame length (feet)

Default - Pole size class: DBH = 5-10" Flame Length: 3.5 feet
Flame length (feet)

Default - Small size class: DBH = 10-20" Flame Length: 6.5 feet
Flame length (feet)

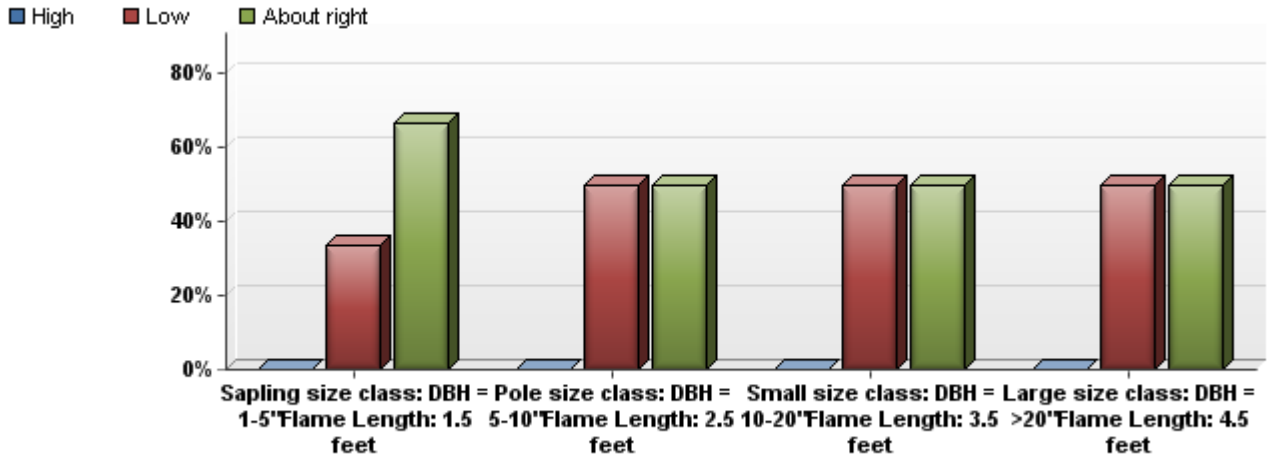
Default - Large size class: DBH = >20" Flame Length: 9.5 feet
Flame length (feet)
8

Please add any brief comments that help explain your answers:

Text Response
Again, I don't think flame lenght is a major contributor to mortality in the oak. The Douglas-fir cannot handle scroched canopy but the oaks are extremely fire resistant.
Same answer as above.
these seem better
Given the canopy and ladder contintiuty and fuels loading, it seems as though you would have 50% mortality. So again with the fuel continuity I believe fire will carry well through the crowns, and the residence time may effect the trees and cambium. I am unclear on fire thresholds for oak.

25) MIXED DOUGLAS-FIR/OAK FOREST

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: 1.5 feet	0	2	4	-0.33
3	Pole size class: DBH = 5-10" Flame Length: 2.5 feet	0	3	3	-0.50
4	Small size class: DBH = 10-20" Flame Length: 3.5 feet	0	3	3	-0.50
5	Large size class: DBH = >20" Flame Length: 4.5 feet	0	3	3	-0.50

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: 1.5 feet
Flame length (feet)
2-4
2.5

Default - Pole size class: DBH = 5-10" Flame Length: 2.5 feet
Flame length (feet)
4-6
4

Default - Small size class: DBH = 10-20" Flame Length: 3.5 feet
Flame length (feet)
6-8
6

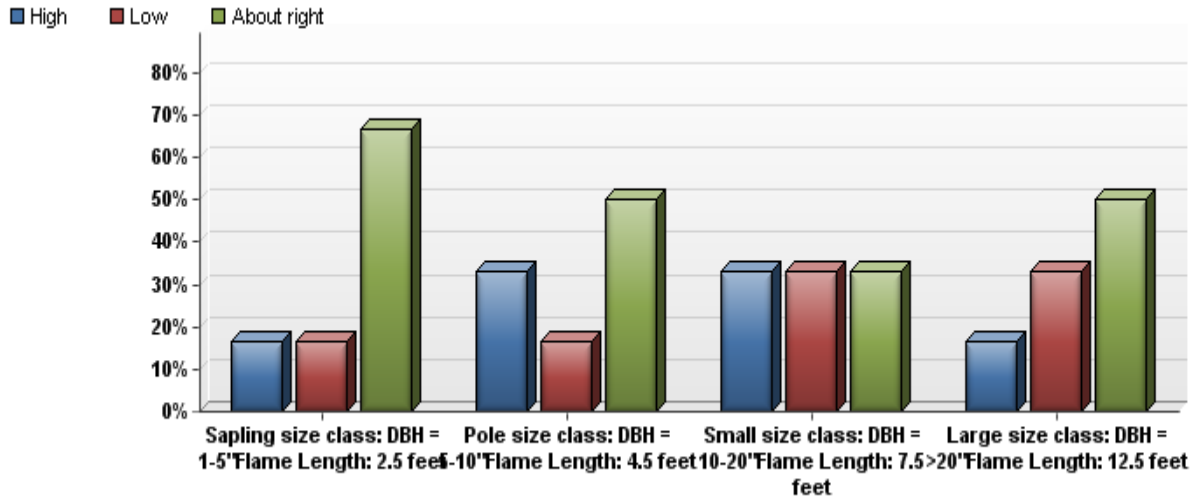
Default - Large size class: DBH = >20" Flame Length: 4.5 feet
Flame length (feet)
10+
8-10

Please add any brief comments that help explain your answers:

Text Response
Same comments as above for the oaks. All answers apply to Douglas-fir. Douglas-fir can develop relatively thick bark (relative to other species of the same size) quite quickly, although I understand that eastside Douglas-fir generally has thicker bark at the same size as compared to westside Douglas-fir. My answers are based more on my experience with eastside Douglas-fir. As Douglas-fir gets larger in diameter, mortality is more dependent on killing the canopy through scorch or direct consumption.
These answers are based on the PSME.

26) OPEN DOUGLAS-FIR WOODLAND

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: 2.5 feet	1	1	4	0.00
3	Pole size class: DBH = 5-10" Flame Length: 4.5 feet	2	1	3	0.17
4	Small size class: DBH = 10-20" Flame Length: 7.5 feet	2	2	2	0.00
5	Large size class: DBH = >20" Flame Length: 12.5 feet	1	2	3	-0.17

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: 2.5 feet
Flame length (feet)
1

Default - Pole size class: DBH = 5-10" Flame Length: 4.5 feet
Flame length (feet)
3
3

Default - Small size class: DBH = 10-20" Flame Length: 7.5 feet
Flame length (feet)
6
6
8-10

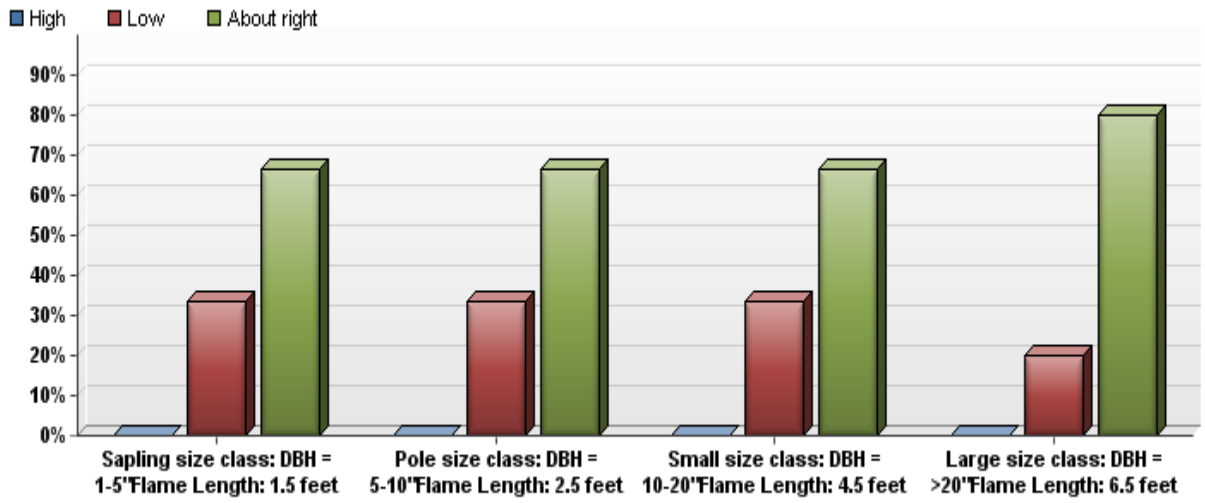
Default - Large size class: DBH = >20" Flame Length: 12.5 feet
Flame length (feet)
12
8
12+

Please add any brief comments that help explain your answers:

Text Response
See answers above
think you will be good mortality as the flame lenght gets up there, based on fuels to gain these hts. as intensity increases the mortality should increase as well. if getting hts due to light flashy fuels then probably will not see the high mortality
Cambium would be the main cause of mortality in the pole and saps. Over 13" PSME can survive taller flame lengths. The large size class would depend on the canopy base height.

27) CLOSED DOUGLAS-FIR FOREST

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: 1.5 feet	0	2	4	-0.33
3	Pole size class: DBH = 5-10" Flame Length: 2.5 feet	0	2	4	-0.33
4	Small size class: DBH = 10-20" Flame Length: 4.5 feet	0	2	4	-0.33
5	Large size class: DBH = >20" Flame Length: 6.5 feet	0	1	4	-0.20

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: 1.5 feet
Flame length (feet)
2-4
2.5

Default - Pole size class: DBH = 5-10" Flame Length: 2.5 feet
Flame length (feet)
4-6
4.5

Default - Small size class: DBH = 10-20" Flame Length: 4.5 feet
Flame length (feet)
6-8
8-10

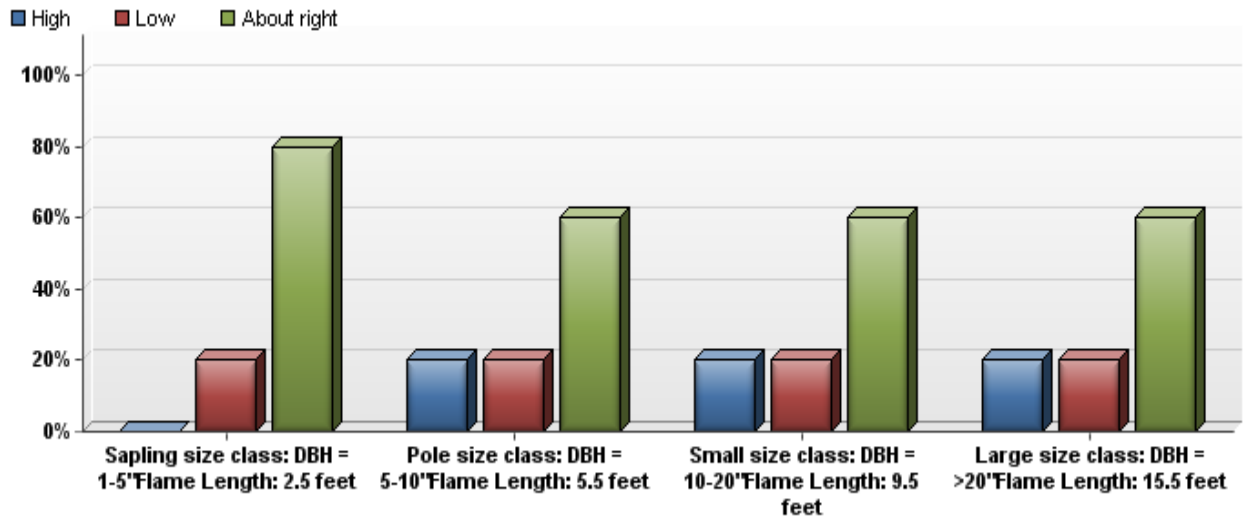
Default - Large size class: DBH = >20" Flame Length: 6.5 feet
Flame length (feet)
8+
12+

Please add any brief comments that help explain your answers:

Text Response
As the trees get larger, you need to kill more of the canopy as the cambium tends to be well protected. The actual flame length needed depends as much on the abundance of shrubs and the dominant species. Since vine maple, for example, does not contribute much to fire behavior, a longer flame length would be needed. If the shrubs were ceanothus, less flame length would be needed since the shrubs would be an active contributor. Shrub continuity also matters, the less continuous, the greater the flame length needed.

28) PONDEROSA PINE SAVANNA

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: 2.5 feet	0	1	4	-0.20
3	Pole size class: DBH = 5-10" Flame Length: 5.5 feet	1	1	3	0.00
4	Small size class: DBH = 10-20" Flame Length: 9.5 feet	1	1	3	0.00
5	Large size class: DBH = >20" Flame Length: 15.5 feet	1	1	3	0.00

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: 2.5 feet
Flame length (feet)
3-4

Default - Pole size class: DBH = 5-10" Flame Length: 5.5 feet
Flame length (feet)
6-7
4.5

Default - Small size class: DBH = 10-20" Flame Length: 9.5 feet
Flame length (feet)
10-12
6.5

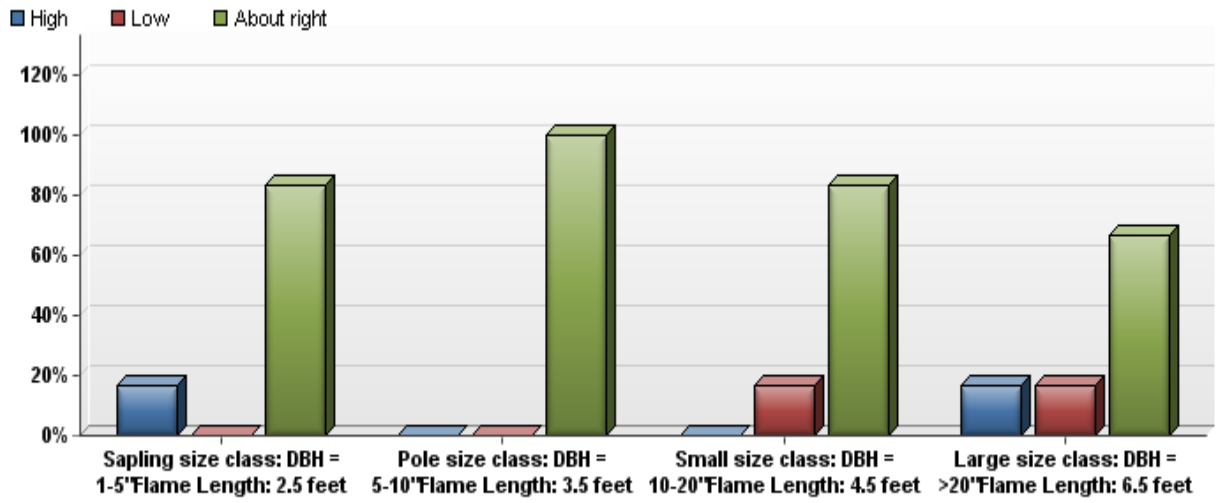
Default - Large size class: DBH = >20" Flame Length: 15.5 feet
Flame length (feet)
16+
9

Please add any brief comments that help explain your answers:

Text Response
My answers are based on my experience with ponderosa pine in the inter-mountain West. I'm not sure how the bark characteristics of the so-called valley pine differ. I think these flame lenghts are on the low side given ponderosa pine bark thickness and tree architecture.

29) PONDEROSA PINE WOODLAND

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: 2.5 feet	1	0	5	0.17
3	Pole size class: DBH = 5-10" Flame Length: 3.5 feet	0	0	6	0.00
4	Small size class: DBH = 10-20" Flame Length: 4.5 feet	0	1	5	-0.17
5	Large size class: DBH = >20" Flame Length: 6.5 feet	1	1	4	0.00

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: 2.5 feet
Flame length (feet)
1.5

Default - Pole size class: DBH = 5-10" Flame Length: 3.5 feet
Flame length (feet)

Default - Small size class: DBH = 10-20" Flame Length: 4.5 feet
Flame length (feet)
6-7

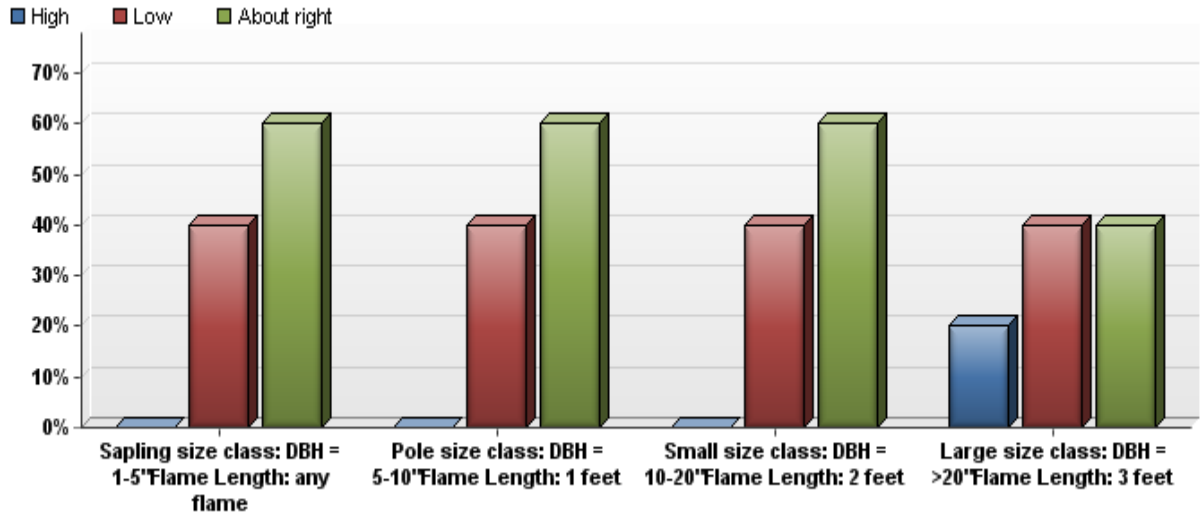
Default - Large size class: DBH = >20" Flame Length: 6.5 feet
Flame length (feet)
8+
5.5

Please add any brief comments that help explain your answers:

Text Response
I think the flame lengths might be on the low side for larger-diameter stands. As with the Douglas-fir example above, much depends on shrub species composition and continuity. If shrubs are more-or-less continuous and of volatile species, then needle-drape reduces the flame length needed over a savannah formation and over a similar stand of Douglas-fir.
The FL on the 10-20" and larger seem a bit low but with the continuous fuel, ground and canopy, I believe you would have a mixed severity fire.

30) BIGLEAF MAPLE FOREST

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: any flame	0	2	3	-0.40
3	Pole size class: DBH = 5-10" Flame Length: 1 feet	0	2	3	-0.40
4	Small size class: DBH = 10-20" Flame Length: 2 feet	0	2	3	-0.40
5	Large size class: DBH = >20" Flame Length: 3 feet	1	2	2	-0.20

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: any flame
Flame length (feet)
0.5

Default - Pole size class: DBH = 5-10" Flame Length: 1 feet
Flame length (feet)
2.5

Default - Small size class: DBH = 10-20" Flame Length: 2 feet
Flame length (feet)
4

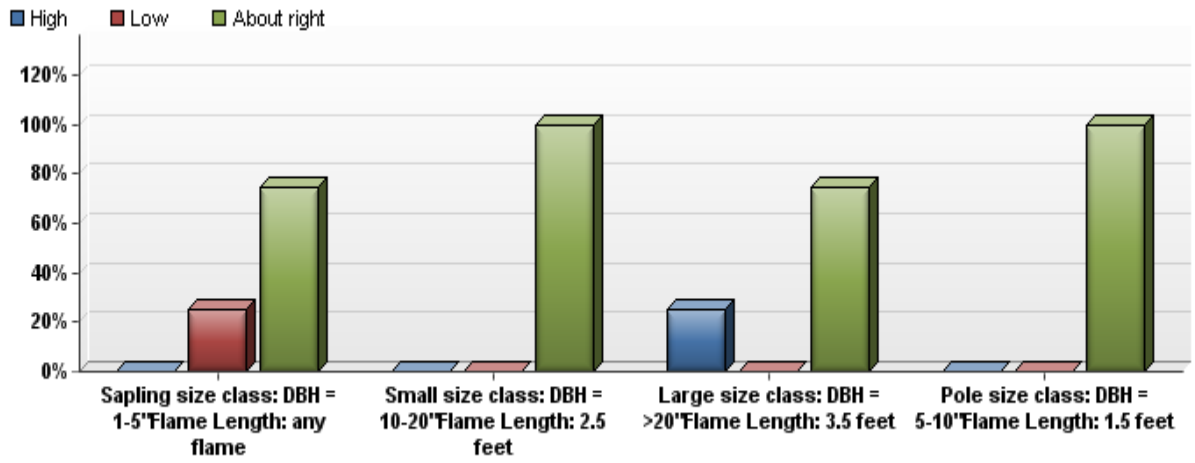
Default - Large size class: DBH = >20" Flame Length: 3 feet
Flame length (feet)
2
6

Please add any brief comments that help explain your answers:

Text Response
At the upper end, the flame length may be a bit too high, given the thin bark of this species. As with oaks, there may be a heat per unit area threshold that's more telling than flame length.
fuel type will be for higher duration burning period resulting in higher intensity increasing impact on mortality.
In my experience, seeing maple burn it carries up the trunks but takes a lot of heat from below to singe or consume the crowns.

31) PACIFIC MADRONE FOREST

Is this flame length threshold too high, low, or about right to cause 50% tree mortality?



#	Question	High	Low	About right	Mean
2	Sapling size class: DBH = 1-5" Flame Length: any flame	0	1	3	-0.25
4	Small size class: DBH = 10-20" Flame Length: 2.5 feet	0	0	4	0.00
5	Large size class: DBH = >20" Flame Length: 3.5 feet	1	0	3	0.25
6	Pole size class: DBH = 5-10" Flame Length: 1.5 feet	0	0	4	0.00

If not about right, what flame length would you say 50% mortality would occur?

Default - Sapling size class: DBH = 1-5" Flame Length: any flame
Flame length (feet)
0.5

Default - Small size class: DBH = 10-20" Flame Length: 2.5 feet
Flame length (feet)

Default - Large size class: DBH = >20" Flame Length: 3.5 feet
Flame length (feet)
2.5

Default - Pole size class: DBH = 5-10" Flame Length: 1.5 feet
Flame length (feet)

Please add any brief comments that help explain your answers:

Text Response
Same answer as for bigleaf maple.
Have not evaluated much after effects of fire in a madrone stand. areas have looked at typically after a fire have had higher mortality due to fire intensity etc... Take all of my input with a grain of salt please. like to walk specific stands and get feel for the fuels and situation. Also like to take some time review Behave model and validate information. Have tried to relate this back to burning we have completed at Mt. Pisgah and Elijah Bristow State Park.
Not familiar with madrone. Feel free to contact me. Mei Lin Lantz, mlantz@fs.fed.us, 541-822-7250. I would be interested to hear how my answers played out with others. This really makes me feel I have some studying to do. .... Thanks.

Fire Survey Results for Calibration

Cody R Evers

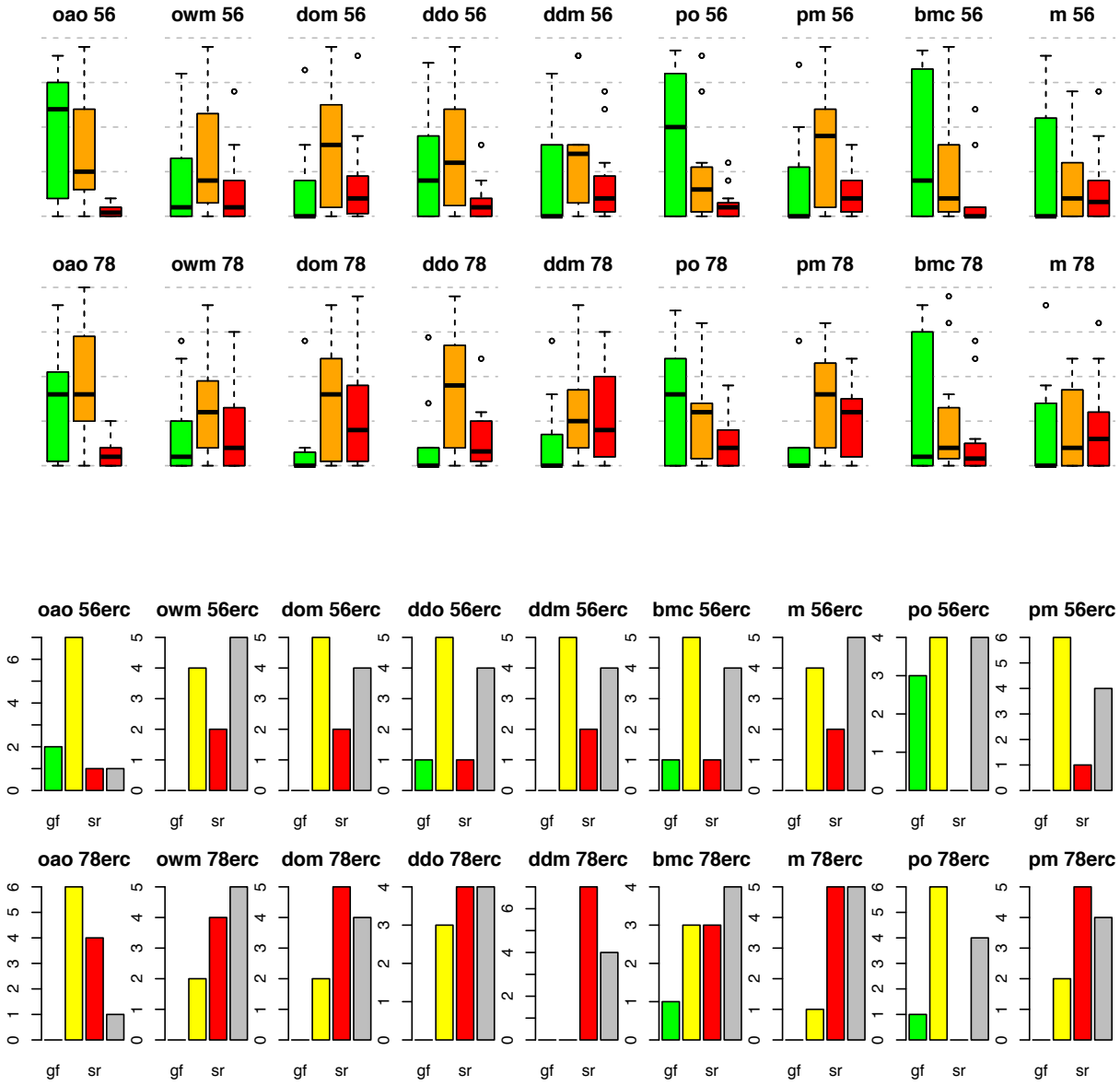
October 2, 2012

0.1 Overview of results

- Bart Johnson noted that the first half of survey respondents were likely more familiar with the questions asked then the second half. For that reasons, results are shown for all respondents and then again subsetting for only the first half.

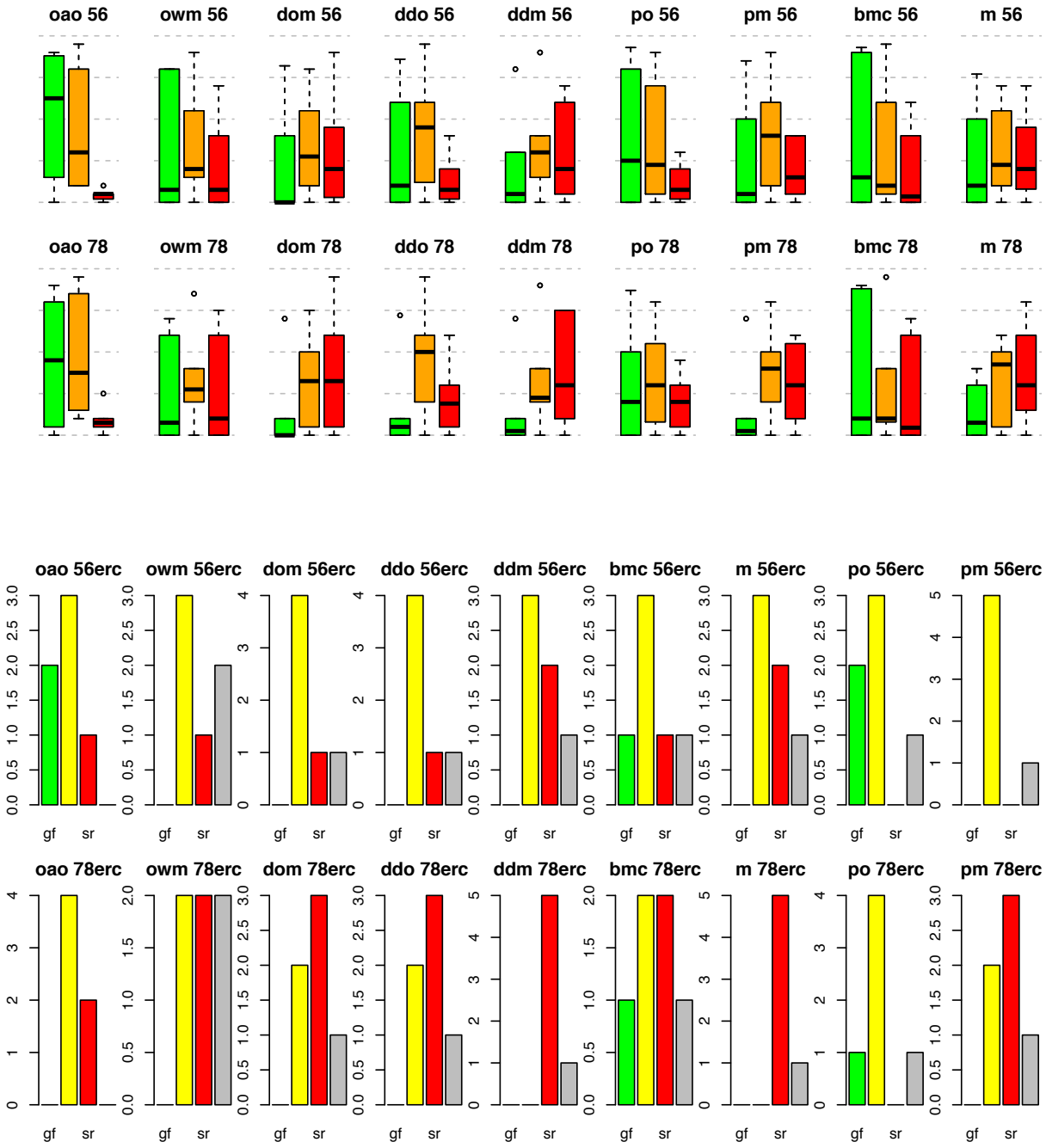
0.2 Crowning behavior

Crowning estimates of fire managers (surveyed July 2012).



0.3 Crowning behavior subset

Crowning estimates of first half of fire managers.



1 Additional question responses

	ResponseID	StartDate	EndDate	Finished	Subset
1	R_6FfksvfT0I4WNYU	2012-05-10 14:51:42	2012-05-10 16:04:25	TRUE	TRUE
2	R_9Fa3oHVmU2cqPHe	2012-05-15 06:26:51	2012-05-15 08:05:40	TRUE	TRUE
3	R_5tdbFbSEC10UXGY	2012-05-15 09:03:32	2012-05-15 09:49:26	TRUE	TRUE
4	R_7PTtmK3vj7G6TpW	2012-05-21 14:53:43	2012-05-21 15:25:37	TRUE	TRUE
5	R_6W0StOpKNYT4KK8	2012-05-16 09:59:16	2012-05-16 09:59:34	FALSE	FALSE
6	R_cUvl7V4LrOcvGao	2012-05-29 11:15:39	2012-05-29 13:18:06	TRUE	TRUE
7	R_enik38JZtsfSEQY	2012-05-21 08:53:17	2012-05-23 13:27:41	FALSE	FALSE
8	R_6XVdsgzJs0wHmmw	2012-06-02 19:53:24	2012-06-03 19:47:12	TRUE	TRUE
9	R_eA8LtJbHyPT8Avi	2012-06-04 07:59:52	2012-06-04 08:45:19	TRUE	FALSE
10	R_7UHEn5923K8Bx8E	2012-06-05 11:30:00	2012-06-05 13:01:28	TRUE	FALSE
11	R_5jvWiS25ZFj1BU8	2012-06-20 07:57:36	2012-06-20 08:05:50	TRUE	FALSE
12	R_es5P27U9GzHGkf2	2012-05-25 11:07:15	2012-05-25 11:10:11	FALSE	FALSE
13	R_38xdwuE2DQ40ftO	2012-06-27 15:03:10	2012-06-27 16:03:40	TRUE	FALSE
14	R_5d41rpoM3N7eEjq	2012-05-31 17:08:12	2012-06-01 17:53:51	FALSE	FALSE

1.1 Oak savanna

1) Open canopy with little ladder fuels, this fuel type would most likely experience individual tree torching with isolated areas of active crown fire. 2) Oaks need summer moisture, which they currently receive, even if not a lot. Timing is more important than amount in that regard, but a minimum amount is necessary. It's unclear if the projected climate would even allow Oregon white oaks to persist in the Willamette Valley. In addition, a shift in the understory species composition is likely. Medusahead is surprisingly widespread in parts of the Willamette Valley. The projected climate in combination with the soils of the Willamette Valley and increasing nitrogen deposition from agriculture and vehicles is more likely to favor medusahead and other annual grasses over perennial grasses, changing the fire dynamics. 3) I do not expect much active crown fire becaused of the open canopy. But with a 22 mph wind most canopies will have fire in them. 4) Not that much difference relative to the variability out there in the fuels. 7) with grass carrying the fire I would think mortaltiy would always be low. I have not seen much mortality except when there is shrub or other fuels to carry the fire and increase residence time. 9) That combination of wind and fuel moisture would kill most vegetation species. In the case of oak it might respond from the root collar or lower stem the following year. 10) I don't feel confident answering these questions. They are assumptions of what I would imagine to see are based on burns in P-J and in shruby grasslands. 13) I'm not sure how to relate this question

1.2 Oak woodland

1) Closed canopy with large concentration of ladder fuels would most likely result in an active crown fire under given conditions. 2) As my answer above, it's unclear if Oregon white oak will continue to persist in the future climate although savannahs are more likely to persist than woodlands due to reduced demand for soil water in the summer. The high shrub component is the greater problem with respect to fire behavior than the oaks in the woodland examples above. Much would depend on the species composition of the shrub layer and whether those species contain a higher proportion of volatiles in their leaves or not (e.g. vine maple verses ceanothus or manzanita). Although the only option offered above is torching, instead, I think you would see more scorch of the overstory with a higher likelihood that the heat produced by a volatile shrub understory would be sufficient to kill more epicormic buds in the oaks, hence killing the trees. 4) It goes up under these conditions, period! 6) Ladder fuels, litter and woody loading under to support fire and

extended duration, moss and lichen in hardwoods (oaks) etc.. 9) Tree density and wind speed of 22 mph is very conducive to crown fire. 10) I have not seen this type of fuel model burning but I compare it to shruby fuels in mid and southern california.

1.3 Douglas-fir over oak

1) Depending on seasonality and live fuel moisture in the ladder fuels, this fuel type would most likely experience an active crown fire under both ERC scenarios. 2) How much active crown fire might result depends on the proportion of Douglas-fir and Oregon white oak. The higher the proportion of Douglas-fir, the greater the likelihood of active crown fire and torching. The higher the proportion of Oregon white, the opposite is true. Future climate is more likely to favor Douglas-fir over Oregon white oak as Douglas-fir is more tolerant of summer drought. 4) Even more burnable. 6) Ladder fuels, mixed with Oaks having moss and lichens etc...

1.4 Douglas-fir over oak

1) Depending on vertical arrangement of fuels, even though it is an open canopy, this fuel type could experience an active crown fire under severe weather conditions. 2) Fuel arrangement in most open conifer woodlands tends to support more surface fire than crown fire. I assumed tree distribution was somewhat clumpy and those clumps would be more likely to torch and crown. Canopy bulk density is usually low enough to limit the amount of crown fire, but under extreme conditions, some active crowning is possible. In the future, likely the live fuel moistures will be lower due to increased summer drought and heat, increasing the probability of frequent torching, short crowning runs and active crown fire even under the lower canopy bulk densities of woodland. 6) grass and shrubs - lower number of ladder fuels, open DF more difficult to get into crown fire stage 10) With the 22 mph wind and the stands partially sheltered there is some potential for the fire to stay on the ground, especially if there are no ladder fuels to carry the fire upward.

1.5 Closed canopy Douglas-fir

1) Again, depending on seasonality and the live fuel moisture and vertical arrangement of ladder fuels, an active crown fire would be likely. 2) Most recent fires in Willamette Valley Douglas fir forests have been mixed severity. The conditions discussed under the woodland above are further exacerbated as canopy closure increases. It's unclear if closed canopy Douglas-fir forest will persist under the future climate at the lower elevations. 3) If it is an older stand with lots of licen and dead material in the canopy it would be high severity 6) ladder fuels, closed canopy higher RH,

1.6 Bigleaf maple

2) As with oaks, bigleaf maple leaf chemistry and canopy bulk density do not support crowning, however bigleaf maple has noncorky bark, making it susceptible to lethal underburning. Under future climate, I would expect bigleaf maple to shift upslope and the understory species composition could shift to support more grasses and fewer forbs. If that happens, then fires could occur more often, further reducing the extent of this type. 4) Seems like this situation is either on the surface or in the crowns. 6) burn the moss and lichens - higher RH and typically shading... fire carry thru moss 10) I am basing this on our prescribed fires where the intensity from the fire on the ground can easily burn leaves and shadded fuels given the low fuel moistures.

1.7 Open pine

2) Canopy bulk density in ponderosa pine savanna is usually too low to support more than occaisional torching in denser clumps under current conditions. Lower live fuel moistures may increase the incidence of torching and short crowning runs in the future, assuming current savanna densities can persist. If savannas

become more open, then the relative proportion of active crown, passive crown and surface fire may change little from the present. 6) open underneath lack of ladder fuels pine stand

1.8 Multi-level pine

2) Multi-story ponderosa pine woodlands have a higher proportion of torching and crowning than pine savannah, tending to result in a mixed severity regime. Under the future climate, I would expect less surface fire and more passive and active crown fire, potentially tipping these systems into stand-replacing, although the higher mortality is likely to come from increases in both the frequency of torching and active crown fire. 4) This one might be in that window where this increased ERC might flip the balance

1.9 Madrone

2) This is a tougher one as I am not as familiar with madrone. The leaves have more volatiles, increasing flammability, but are thick, which reduces flammability. The species is very thin barked, making it highly susceptible to lethal underburning, but also sprouts quite readily. Madrone is more tolerant of summer drought than species like maples. It could be that in the future, fire frequency reduces the proportion of tree-sized madrone and it becomes more of a shrub species in the understory of a conifer woodland or savannah. 6) Don't know that i have a great answer for anything on this page... all estimates and feelings at this time. if had time could possible run thru Behave etc... but sure you all can do and probably already have done this as well to get a better understanding. 10) Have not seen fire in madrone forests.

1.10 Mortality estimates

Count of responses that said the flame length listed was approximately where 50% mortality would occur (OK), or that it was too low (L) or too high (H). Most frequent response marked with "*".

	covtype	sc	fl	OK	H	L
1	oao	y	2.5	5*	2	0
2	oao	p	4.5	5*	2	0
3	oao	s	9.5	4*	2	0
4	oao	l	12.5	4*	2	0
5	owm	y	2.5	6*	0	0
6	owm	p	3.5	5*	0	1
7	owm	s	6.5	4*	0	2
8	owm	l	9.5	3*	1	2
9	dom	y	1.5	5*	0	2
10	dom	p	2.5	4*	0	3
11	dom	s	3.5	3	0	4*
12	dom	l	4.5	3	0	4*
13	ddo	y	2.5	5*	1	1
14	ddo	p	4.5	4*	2	1
15	ddo	s	7.5	3*	2	2
16	ddo	l	12.5	4*	1	2
17	ddm	y	1.5	5*	0	2
18	ddm	p	2.5	5*	0	2
19	ddm	s	4.5	5*	0	2
20	ddm	l	6.5	4*	0	2
21	bmc	y	0.5	4*	0	2
22	bmc	p	1	4*	0	2
23	bmc	s	2	4*	0	2
24	bmc	l	8*	2	1	3*
25	pm	y	7	6*	1	0
26	pm	p	9	7*	0	0
27	pm	s	10	5*	0	2
28	pm	l	12	4*	1	2
29	po	y	7	5*	0	1
30	po	p	11	4*	1	1
31	po	s	14	4*	1	1
32	po	l	5	4*	1	1
33	m	y	1	5*	1	1
34	m	p	7	4*	2	1
35	m	s	9	3*	2	2
36	m	l	3	4*	1	2

1.11 Mortality estimates subset

Subset of responses of first half of fire managers. Most frequent response marked with "*".

	covtype	sc	fl	OK	H	L
1	oao	y	2.5	2*	2*	0
2	oao	p	4.5	3*	1	0
3	oao	s	9.5	2*	1	0
4	oao	l	12.5	2*	1	0
5	owm	y	2.5	3*	0	0
6	owm	p	3.5	2*	0	1
7	owm	s	6.5	2*	0	1
8	owm	l	9.5	2*	0	1
9	dom	y	1.5	3*	0	1
10	dom	p	2.5	2*	0	2*
11	dom	s	3.5	2*	0	2*
12	dom	l	4.5	2*	0	2*
13	ddo	y	2.5	2*	1	1
14	ddo	p	4.5	2*	1	1
15	ddo	s	7.5	2*	1	1
16	ddo	l	12.5	3*	0	1
17	ddm	y	1.5	3*	0	1
18	ddm	p	2.5	3*	0	1
19	ddm	s	4.5	3*	0	1
20	ddm	l	6.5	3*	0	1
21	bmc	y	0.5	2*	0	1
22	bmc	p	1	2*	0	1
23	bmc	s	6*	2*	0	1
24	bmc	l	8	1*	1*	1*
25	pm	y	7	4*	0	0
26	pm	p	9	4*	0	0
27	pm	s	10	3*	0	1
28	pm	l	12	3*	0	1
29	po	y	7	2*	0	1
30	po	p	11	2*	0	1
31	po	s	14	2*	0	1
32	po	l	5	2*	0	1
33	m	y	1	2*	1	1
34	m	p	7	2*	1	1
35	m	s	9	2*	1	1
36	m	l	3	3*	0	1