Assessing Fire Damaged Trees

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Common post-fire questions:

- Will trees die from fire injury?
- Will there be a bark beetle outbreak?
- How long will the wood be salvageable?

Stickpin Fire

When and where will the morels appear?

Will trees die from fire injury?

Stickpin Fire

Major Factors Influencing Fire Injury

- Season wildfire occurred
- Pre-fire site quality
- Amount of woody debris

Tower Fire, October 2015

Sensitivity to fire injury varies by tree species and size and vigor

Thin bark ← more sensitive ← **Thick bark**

young trees, grand fir, Douglas-fir, ponderosa pine

Small buds ← more sensitive ← **Large buds**

Douglas-fir ponderosa pine

Poor health ← more sensitive ← **Good health**

Small % live crown

Small recent diameter growth

Dwarf mistletoe infected

How were trees injured?

- Foliage consumption
- Needle set
- Crown scorch volume
- Stem char

Stickpin Fire

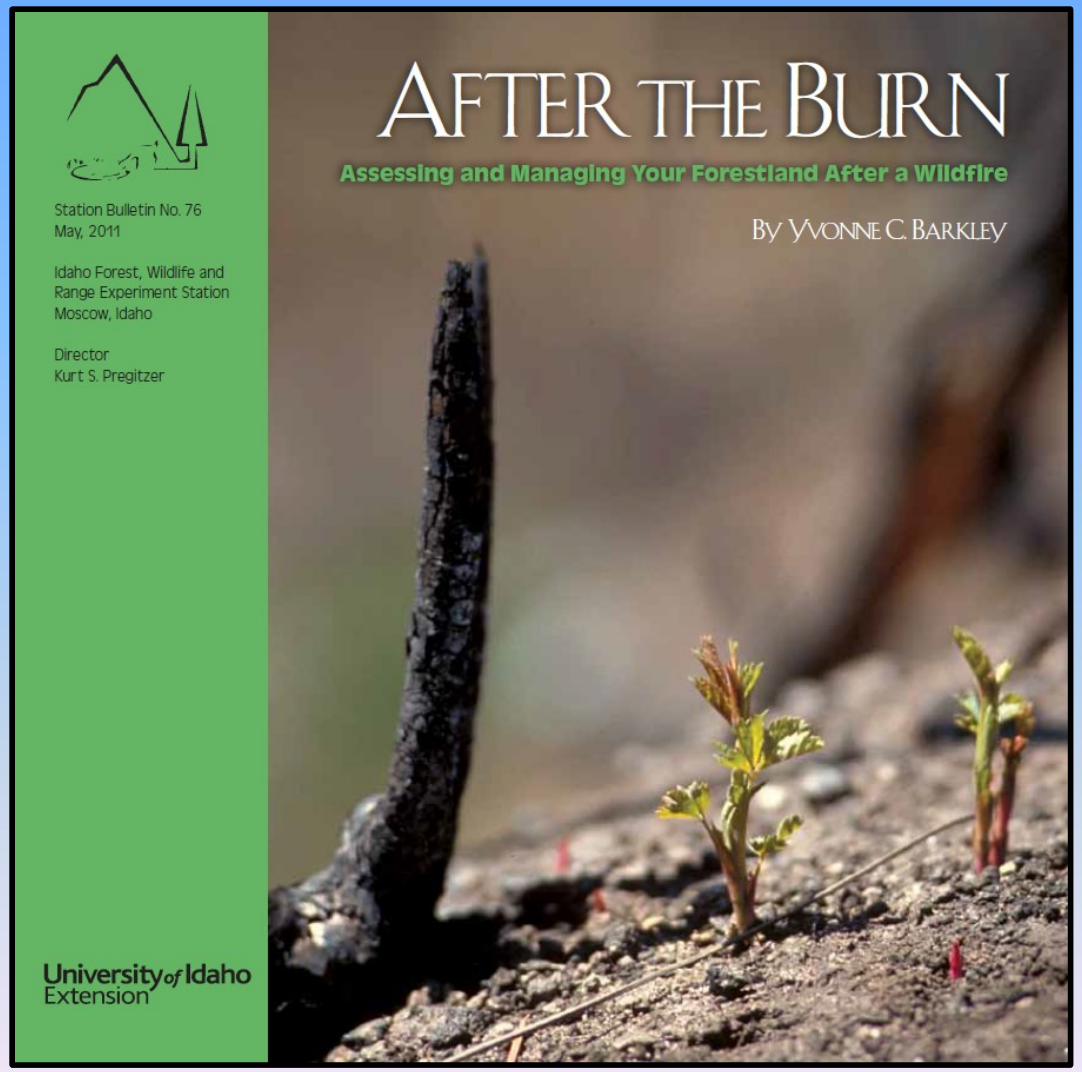
Foliage Consumption

Needle Set

Stickpin Fire

Crown Scorch Volume

- Estimate what percent of the volume of the previously living crown is now scorched



Crown Scorch Volume

40% Scorch

DBH = 20”

70% Scorch

DBH = 14”

Table 2: Probability of fire-induced mortality for ponderosa pine.

	CROWN SCORCH VOLUME (PERCENT)									
DBH	10	20	30	40	50	60	70	80	90	100
5	49%	53%	60%	68%	78%	86%	93%	97%	99%	99%
6	42%	46%	53%	62%	72%	83%	90%	95%	98%	99%
7	36%	40%	46%	55%	67%	78%	88%	94%	98%	99%
8	30%	34%	40%	49%	61%	74%	85%	93%	97%	99%
9	25%	28%	34%	43%	55%	69%	82%	91%	96%	99%
10	21%	24%	29%	37%	49%	64%	78%	89%	95%	98%
12	15%	17%	21%	28%	39%	53%	69%	84%	93%	97%
14	11%	12%	10%	21%	30%	43%	61%	77%	90%	96%
16	8%	9%	7%	16%	23%	35%	52%	71%	86%	94%
18	6%	7%	6%	12%	18%	29%	45%	65%	82%	93%
20	5%	5%	4%	10%	15%	24%	39%	59%	78%	91%
22	4%	4%	4%	8%	13%	21%	34%	54%	74%	89%
24	3%	4%	3%	7%	11%	18%	31%	50%	71%	87%
26	3%	3%	3%	6%	10%	16%	28%	47%	69%	86%
28	3%	3%	3%	6%	9%	15%	27%	45%	67%	85%
30	3%	3%	3%	6%	9%	15%	26%	44%	67%	85%

Sources/Notes: Table developed by David C. Powell, Forest Silviculturist, Umatilla National Forest, Pendleton, OR. These values are probabilities, expressed as a percent, of ponderosa pines of various diameters being killed by fire. They are based on an equation from Reinhardt and Ryan (1989) and a bark thickness factor from Keane et al. (1989). See Steele et al. (1996) for a description of the calculation methodology. White values on a blue background denote combinations of crown scorch and DBH with a mortality probability ≥ 50%.

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9	25%	28%	34%	43%	55%	69%	82%	91%	96%	99%
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12	15%	17%	21%	28%	39%	53%	69%	84%	93%	97%
14	11%	12%	10%	21%	30%	43%	61%	77%	90%	96%
16	8%	9%	7%	16%	23%	35%	52%	71%	86%	94%
18	6%	7%	6%	12%	18%	29%	45%	65%	82%	93%
20	5%	5%	4%	10%	15%	24%	39%	59%	78%	91%
22	4%	4%	4%	8%	13%	21%	34%	54%	74%	89%
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Table 6: Probability of fire-induced mortality for lodgepole pine.

	CROWN SCORCH VOLUME (PERCENT)									
DBH	10	20	30	40	50	60	70	80	90	100
5	77%	79%	83%	88%	92%	96%	98%	99%	100%	100%
6	75%	78%	82%	87%	92%	95%	98%	99%	100%	100%
7	74%	77%	81%	86%	91%	95%	97%	99%	100%	100%
8	73%	76%	80%	86%	91%	95%	97%	99%	99%	100%
9	72%	75%	79%	85%	90%	94%	97%	99%	99%	100%
10	70%	74%	78%	84%	90%	94%	97%	99%	99%	100%
12	68%	71%	76%	82%	88%	93%	96%	98%	99%	100%
14	65%	68%	74%	80%	87%	92%	96%	98%	99%	100%
16	62%	66%	71%	78%	85%	91%	96%	98%	99%	100%
18	59%	63%	69%	76%	84%	90%	95%	98%	99%	100%
20	56%	60%	66%	74%	82%	89%	94%	97%	99%	100%
22	53%	57%	64%	72%	80%	88%	94%	97%	99%	100%
24	50%	54%	61%	69%	79%	87%	93%	97%	99%	100%
26	48%	52%	58%	67%	77%	86%	92%	96%	98%	99%
28	45%	49%	55%	64%	75%	84%	91%	96%	98%	99%
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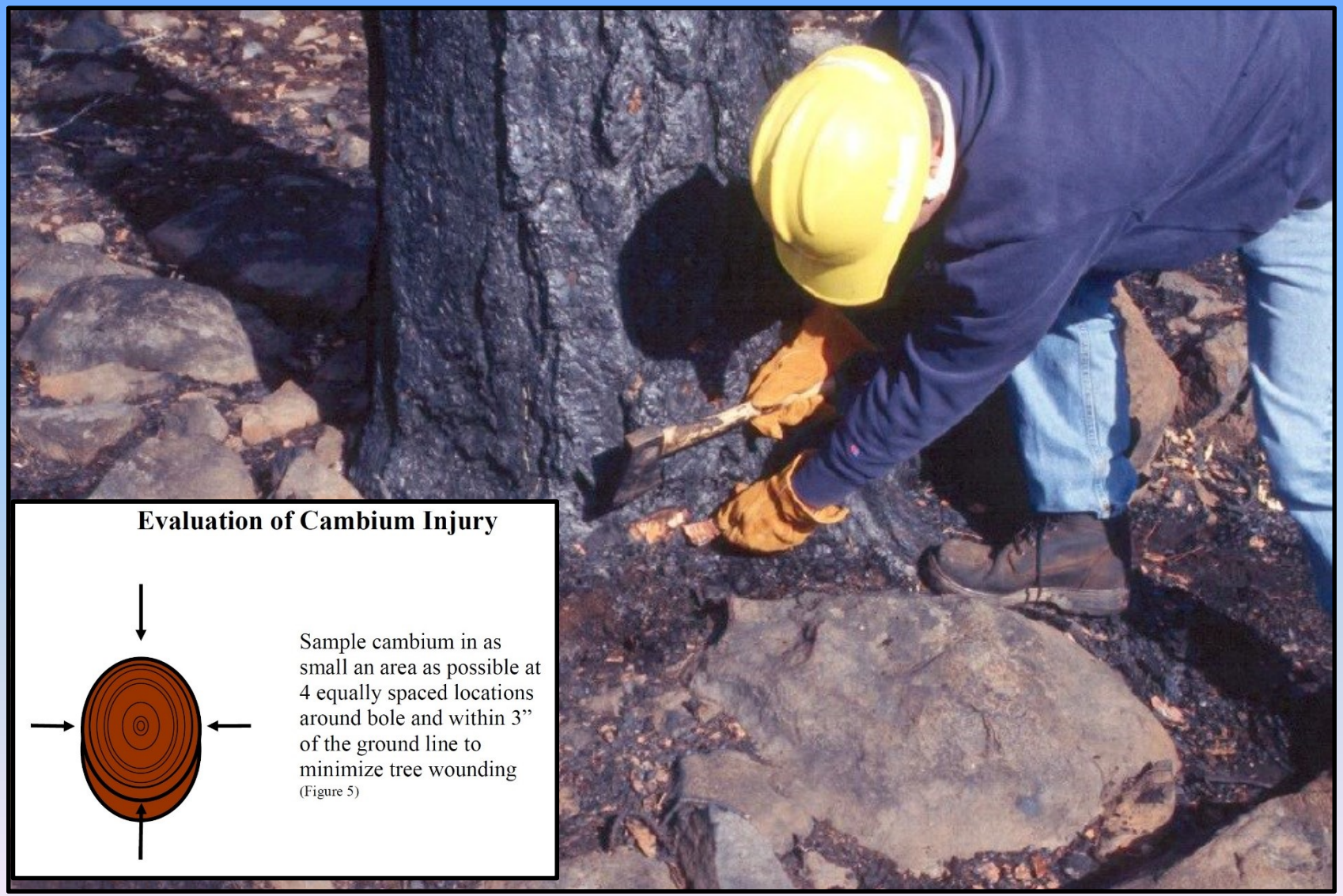
Did the buds survive?

Photo: Montana State University

Stem Char

Stickpin Fire

Stem Char


Evaluation of Cambium Injury
Sample cambium in as small an area as possible at 4 equally spaced locations around bole and within 3” of the ground line to minimize tree wounding
(Figure 5)

Will trees die from fire injury?

- Surrogate for cambium exam

Photo: Chris Schnepf, University of Idaho

Table 4. Bark char codes and description of bark appearance (adapted from Ryan 1982).

Bark char code	Bark appearance
Unburned	No char
Light	Evidence of light scorching; can still identify species based on bark characteristics; bark is not completely blackened; edges of bark plates charred
Moderate	Bark is uniformly black except possibly some inner fissures; species bark characteristics still discernable
Deep	Bark has been burned into, but not necessarily to the wood; outer bark species characteristics are lost

Will trees die from fire injury?

- Surrogate for cambium exam

Photo: Chris Schnepf, University of Idaho

Table 10. Recommended management guidelines for using Ryan (1982) bark char codes as a surrogate for direct cambium sampling after fire. Species/code combinations not listed are not clearly associated with either live or dead cambium and should be sampled directly to determine injury.

Species	Bark Char Code	Probable Cambium Status
Lodgepole pine Whitebark pine Western white pine Western red cedar Engelmann spruce Western hemlock Subalpine fir	Light, moderate, or deep	Dead
White fir Incense cedar Ponderosa pine Jeffrey pine Douglas-fir Sugar pine	Light	Alive
White fir Incense cedar Ponderosa pine (wildfire) Jeffrey pine (wildfire) Douglas-fir (wildfire) Sugar pine	Deep	Dead
Ponderosa pine Jeffrey pine (prescribed fire)[1]	Moderate or deep	Alive
Douglas-fir (prescribed fire)[1]	Moderate	Alive
Western larch	Light, moderate, or deep	Alive

[1]If pre-fire duff mound depths are high and most of duff is consumed in fire, then the probability of cambium mortality is higher.

Stickpin Fire, Survivors

Will there be a bark beetle outbreak?

Many different insect species use fire killed/injured trees

- Important ecological roles
- Biggest impacts to forest managers:
  - bark beetles killing live trees
  - associated bluestain
  - damage to wood products

Will there be a bark beetle outbreak?

- Phloem needs to be fresh (AKA not cooked dry) - limited bark char

NOT THIS

THIS

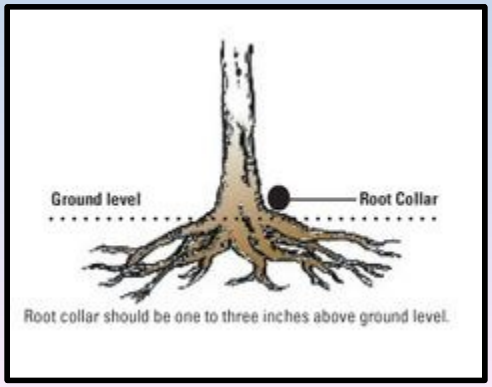
Severe Burns

- Few severely burned trees will be infested
  - unsuitable habitat

Stickpin Fire

Light Burns

- Look for trees that have little apparent bole or crown damage, but may be completely girdled at the root collar (can use stem char method)



Tower Fire

Moderate Burns

- Greatest risk of bark beetle infestation

The Whisky Fire, NM

Will there be a bark beetle outbreak?

- Needs to be sizable bark beetle population nearby
- Less likely after late season fires (late August and after)

Bark Beetle Species

- **Mountain pine beetle:**
  hosts – all pines
- **Western pine beetle:**
  host – ponderosa pine
- **Red turpentine beetle:**
  hosts – all pines
- **Fir Engraver:**
  hosts – grand fir
- **Pine engraver:**
  hosts – all pines
- **Douglas-fir beetle:**
  hosts – Douglas-fir, downed western larch

Mountain Pine Beetle

(Dendroctonus ponderosae)

- Active in >8 inch diameter lodgepole and pole sized low-vigor ponderosa
- Normally breeds in stressed, injured, diseased trees resulting in scattered mortality
- Outbreak populations kill apparently healthy trees over extensive areas

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9	72%	75%	79%	85%	90%	94%	97%	99%	99%	100%
10	70%	74%	78%	84%	90%	94%	97%	99%	99%	100%
12	68%	71%	76%	82%	88%	93%	96%	98%	99%	100%
14	65%	68%	74%	80%	87%	92%	96%	98%	99%	100%
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18	59%	63%	69%	76%	84%	90%	95%	98%	99%	100%
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22	53%	57%	64%	72%	80%	88%	94%	97%	99%	100%
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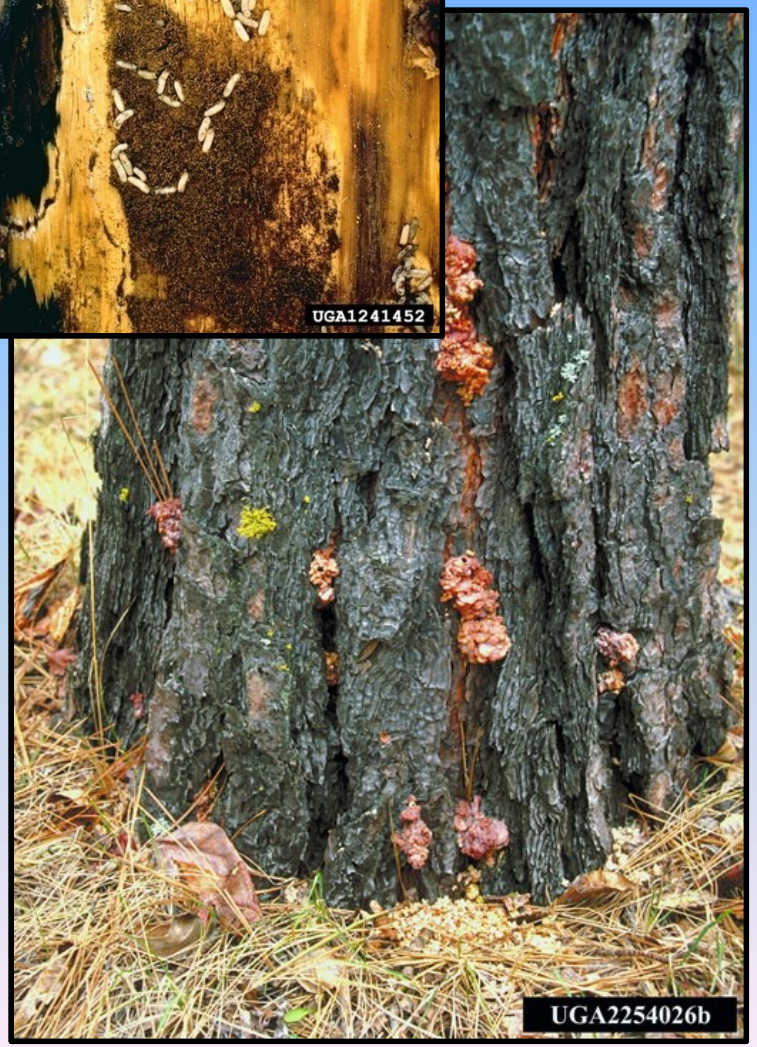
Western Pine Beetle

(Dendroctonus brevicomis)

- Prefers mature or weakened trees
- Outbreaks follow drought
- Overlapping broods, 1-2 generations per year
- Commonly group kill

Red Turpentine Beetle
(*Dendroctonus valens*)



- Most pines are hosts
- Usually attack bottom 6 ft
- Common on stressed or fire scorched trees, stumps
- “Cave” larval gallery
- Forms large, ‘grainy’ pitch tubes near the base
- Considered a “secondary” bark beetle

Post-fire management of pine bark beetles

- Salvage fire damaged and infested pines before summer flight (consider season and severity of fire)
- Manage stand density to increase tree vigor
- Can use pesticides to prevent attacks on high value trees

Spring 2008. After early August 2007 fire (Domke Lake)

Fir Engraver (*Scolytus ventralis*)

- Host: True fir
- Attacks weakened, dying or recently killed fir trees
- Salvage fire damage trees

Pine Engraver (*Ips pini*)

- Breed in fresh dead pine > 3 inches diameter (preferred over live trees)
- Several generations per year
- Large amounts of fire damaged trees can rapidly increase populations which can attack nearby live pine (usually small trees or tops of larger trees)

Pine Engraver Management Options

- Salvage fire damage
- Don’t leave fresh breeding material >3” diameter from Jan to July (unless treated)
- **Pile and burn** before flight (Mar – April)

Pine slash management options:

- Direct removal
- Chipping (remove or scatter)
- Lop and scatter in open areas – done in late summer/fall
- Don’t stack wood near live trees
- Outbreaks typically collapse after one year (high overwintering mortality, less host material)

Douglas-fir Beetle

(Dendroctonus pseudotsugae)

- **Hosts:** Douglas-fir, downed green western larch
- Breeds in felled, injured or diseased trees, resulting in widely scattered mortality
- Prefers >14 inch DBH trees
- Epidemic populations kill apparently healthy trees over extensive areas
- Commonly group kill

Post-fire Douglas-fir beetle management

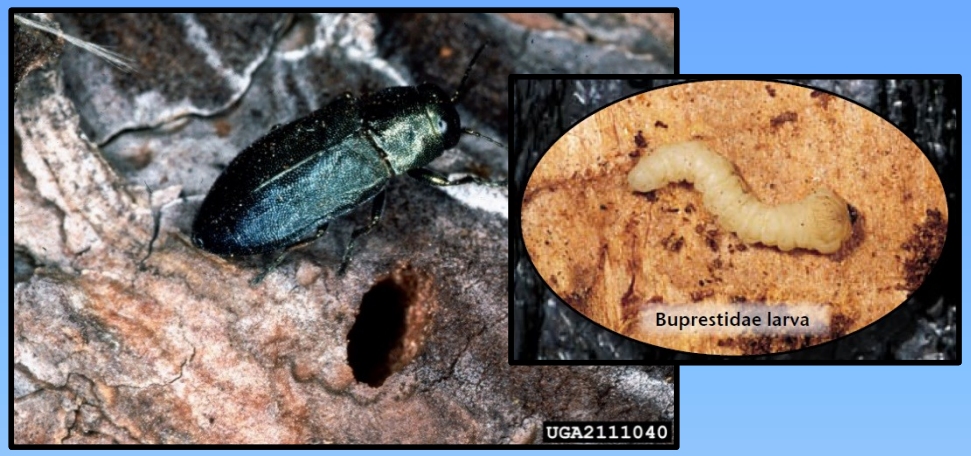
- DF less than 10” DBH is at low risk for outbreak
- After early season fire: salvage infested trees before spring flight
- After late season fire: salvage damaged trees before two springs pass

MCH (anti-aggregation pheromone)

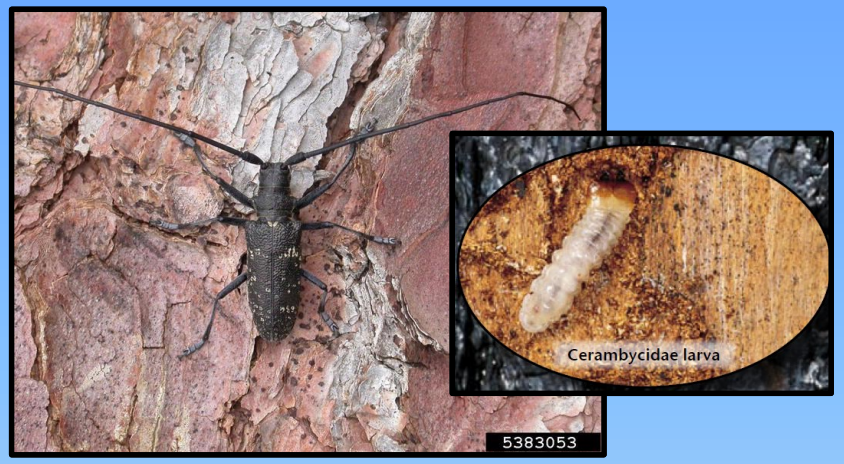
- Used to prevent Douglas-fir beetle attacks
- Best for high value stands – campgrounds, timber sale, old growth
- Can be applied by hand (bubble caps) or from the air (flakes)
- Must be applied before April flight

How long will the wood be salvageable?

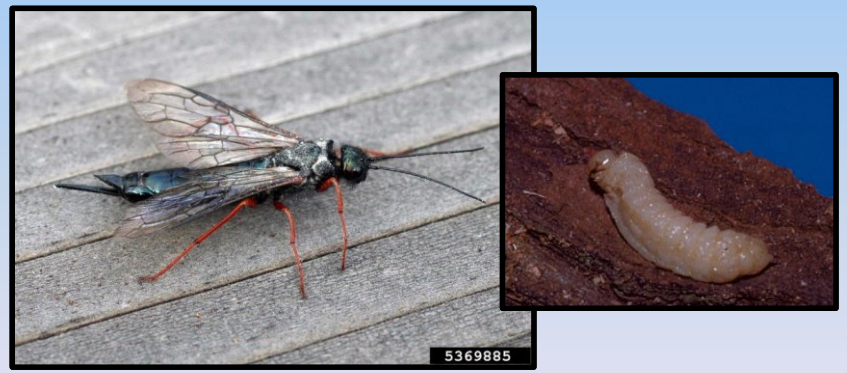
Three families of wood borers



Metallic wood borers
Flat-headed wood borers
Family Buprestidae



Long-horned wood borers
Round-headed wood borers
Family Cerambycidae



Woodwasps
Other colorful names
Family Siricidae

Bark beetle larva

How long will the wood be salvageable?

- Some wood borers attack before fire is out

"Fire bug"
(*Melanophila acuminata*) has infrared sensors

- Wood borers may tunnel in sapwood within a few months of fire

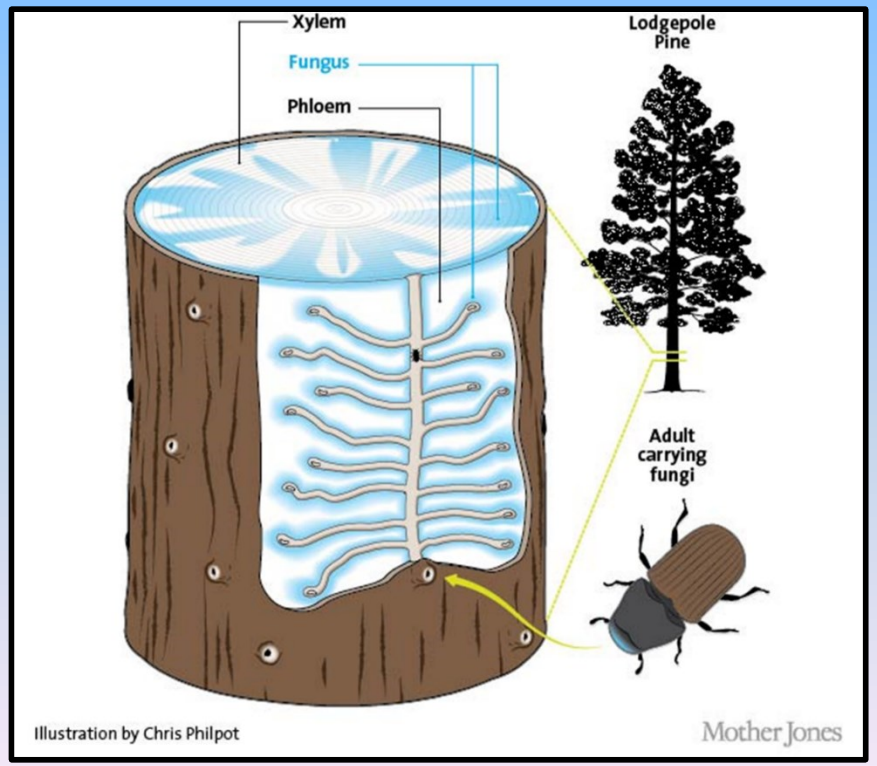
Ambrosia Beetles

How long will the wood be salvageable?

- Ambrosia beetles can enter sapwood immediately after the fire and into the first year (don't use phloem)
- Require moisture

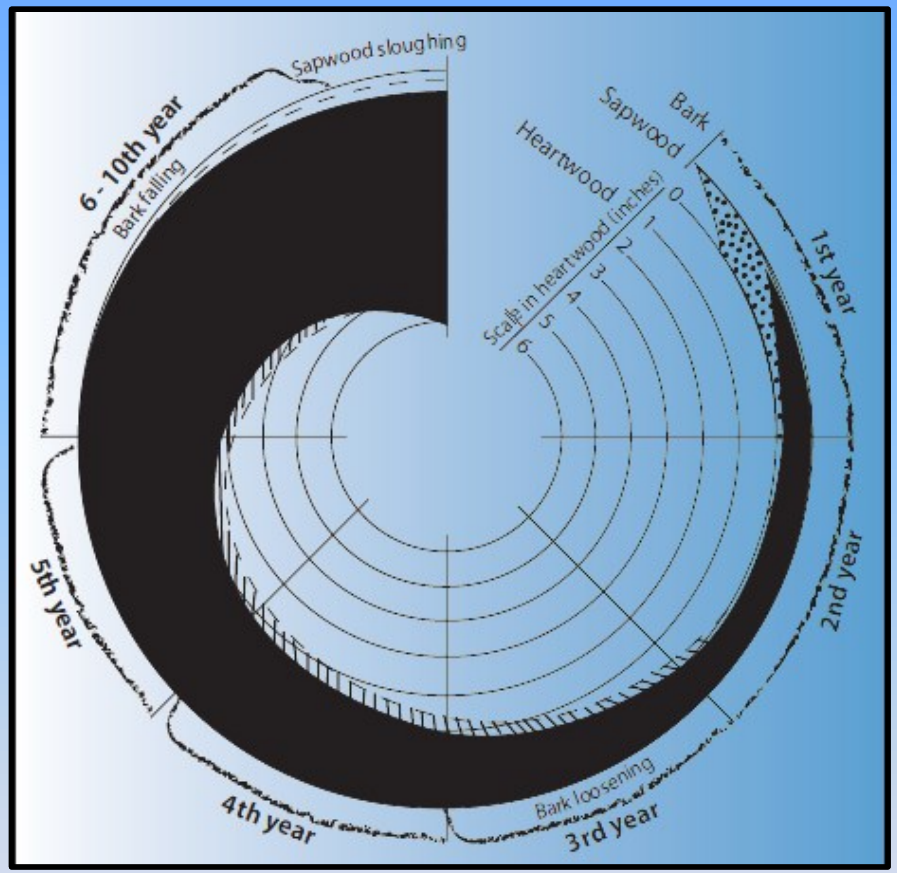
How long will the wood be salvageable?

- In trees attacked by bark beetles and/ or wood borers, bluestain can appear within weeks
- Bluestain growth slows later in season
- Bark beetles & wood borers can't use severely burned trees, so this limits bluestain in these trees
- **Salvage appearance-grade wood within 1-2 months**



How long will the wood be salvageable?

- Decay fungi damage sapwood within 6 months and heartwood starting second year
- **Salvage for dimensional grade within 6 months**



Decay rate of fire killed Douglas-fir

Summary:

- Will trees die from fire injury?/ Will there be a bark beetle outbreak?
  - Determine risk of mortality
    - Assess tree injuries and survival
      - Species affected, timing, and severity
    - Injured and weakened trees are more likely to be killed by bark beetles next year
    - Salvage or treat infested trees before bark beetle brood flight

Summary:

- How long will the wood be salvageable?
  - Pine staining and wood boring insect activity start right away
  - Prioritize salvage for high value products
  - Manage to optimize tree vigor and meet long term objectives
  - Leave a few wildlife trees per acre!

Acknowledgements

- Karen Ripley, Forest Health Program Manager, WDNR
- Glenn Kohler, Entomologist, WDNR
- Bugwood Network (www.bugwood.org)
- Forestry Images (www.forestryimages.org)

Resources

After the Burn: Assessing and Managing Your Forestland After a Wildfire. Yvonne C. Barkley. 2011. University of Idaho Extension Bulletin 76.

Delayed tree mortality following fire in western conifers. S. Hood, S. Smith, D. Cluck, E. Reinhardt, K. Ryan, C. McHugh. 2008. Joint Fire Science Program. 05-2-1-105.

Factors Affecting Survival of Fire Injured Trees: A Rating System for Determining Relative Probability of Survival of Conifers in the Blue and Wallowa Mountains. November 2002. D.W. Scott, C.L. Schmitt, L.H. Spiegel. USDA Forest Service. BMPMSC-03-01.