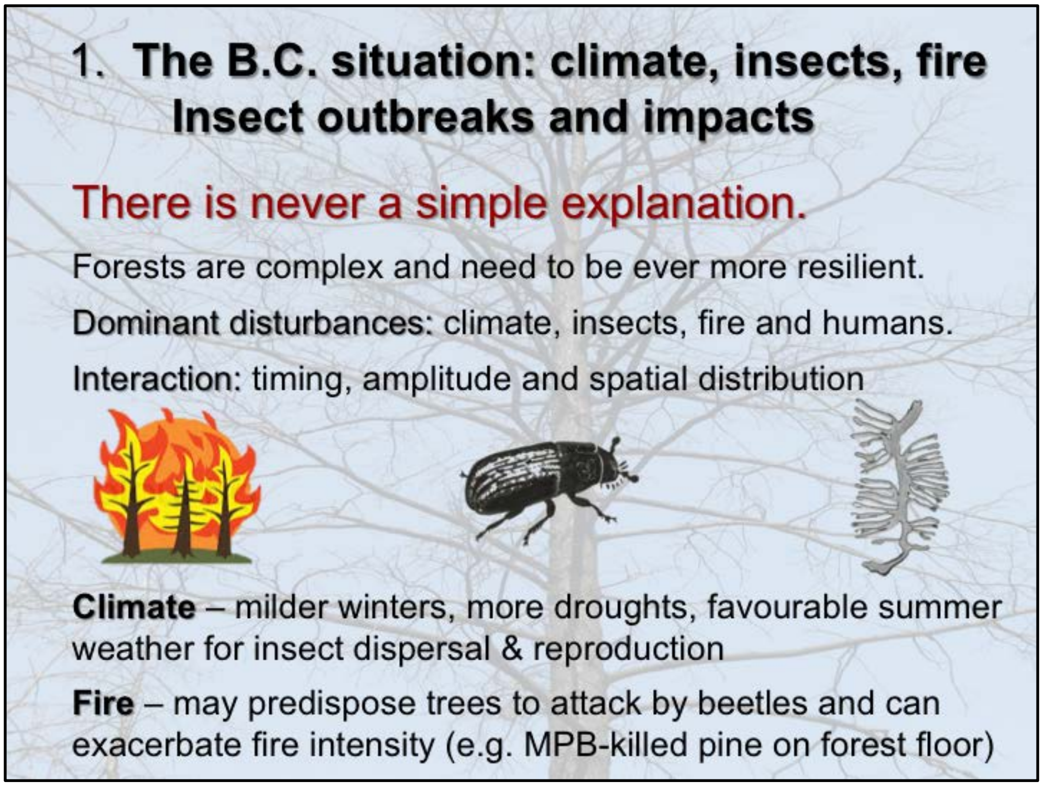
Emphasis on the 2017 wildfires, what happened in the Cariboo/Chilcoltin and why, plus what can be done to prevent a re-occurrence around other communities.

1. The B.C. situation and how we got here: climate, fire, insects (background and interactions)
2. Insect outbreaks and impacts – ramped-up cycling (larger, more intense, more frequent, longer lasting)
3. Douglas-fir beetle & wildfire
   a) Life history & host selection
   b) Current status of DFB and fires (map, graph)
   c) Fire-DFB interaction
4. Management tactics – but what is the B.C. strategy? (landscape approach vs. localized approach)



There is never a simple explanation.

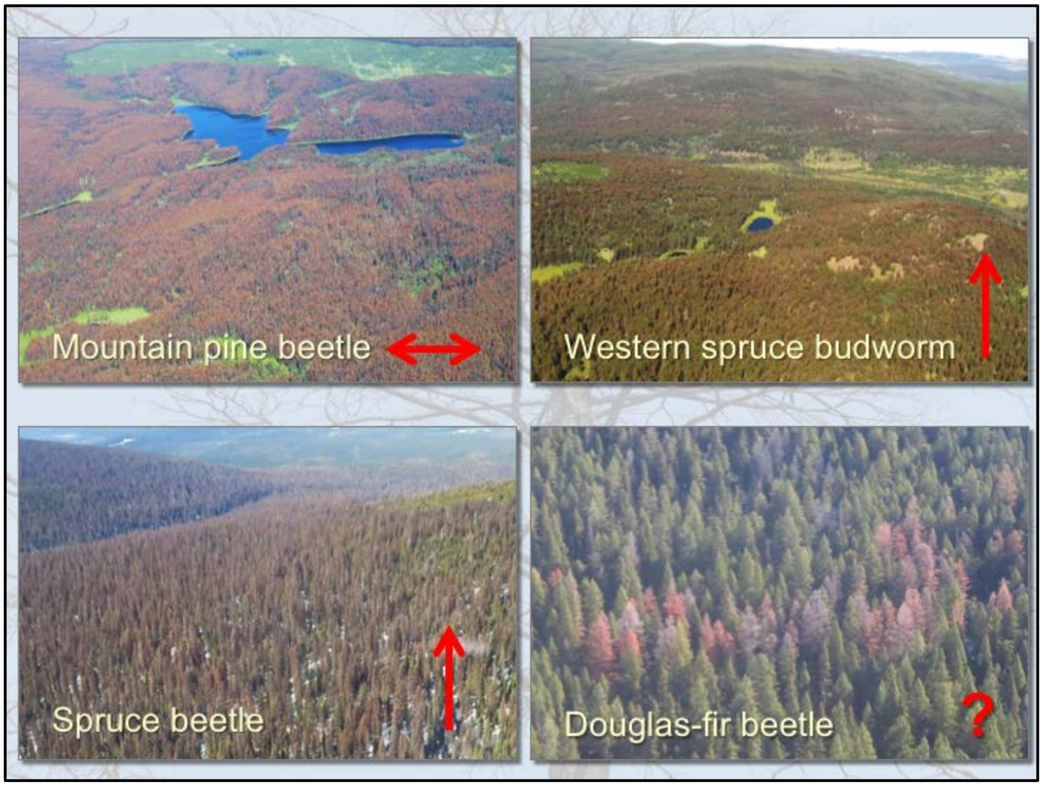
Our natural forests are complex and need to be ever more resilient

Parameters affecting forests are changing and at an ever increasing pace.

Dominant disturbances are: climate, insects and fire. They continually interact and in different ways: timing, amplitude and spatial distribution

Climate – milder winters, more droughts and favourable summer weather for insect dispersal & reproduction

Fire – may predispose trees to attack by beetles and can exacerbate fire intensity (e.g. MPB-killed pine on forest floor)



The BC Situation – climate, insects and fire.

There is never a simple explanation.

Our natural forests are tremendously complex and resilient.

However, parameters affecting trees/forests have been changing and at an ever increasing pace.

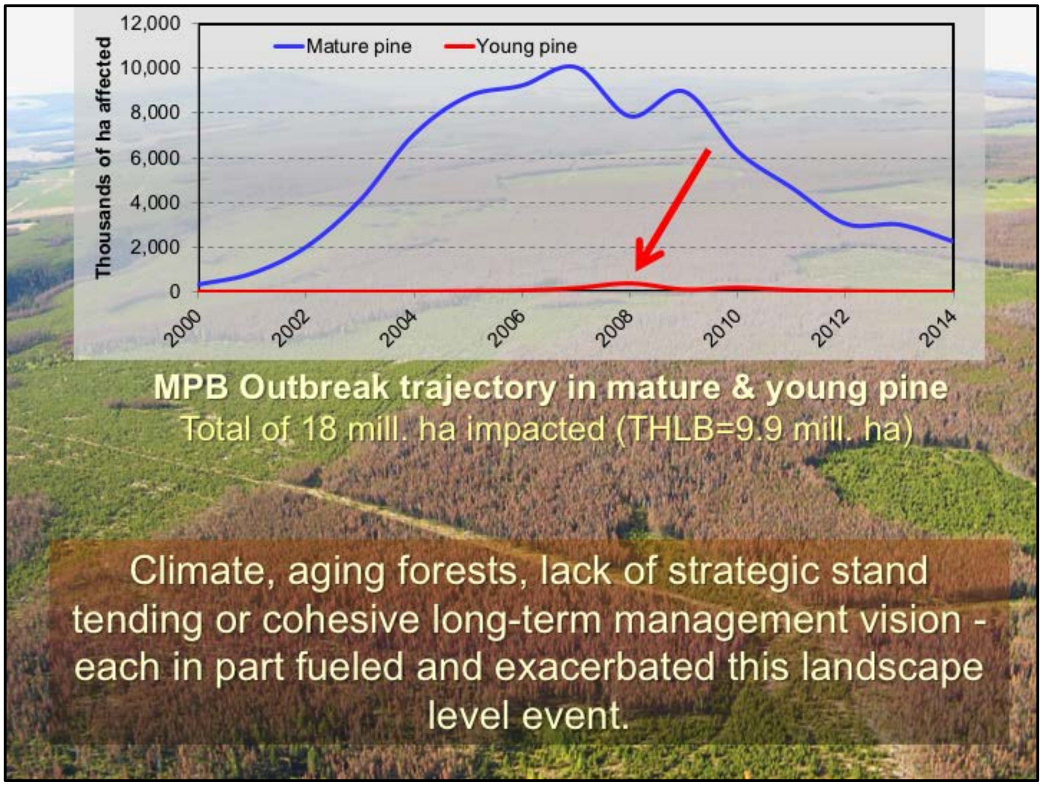
The most dominant disturbances are climate, insects and fire. They continually interact and in different ways depending upon the timing, amplitude and spatial distribution of events or influencing factors.

Climate – milder winters, more droughts and favourable summer weather for insect dispersal & reproduction

Fire – can predispose trees to attack by beetles <u>and</u> can exacerbate fire intensity (e.g. MPB-killed pine now falling causing fuel build-up)

Climate-fire interaction – that's for the fire expert to explain.

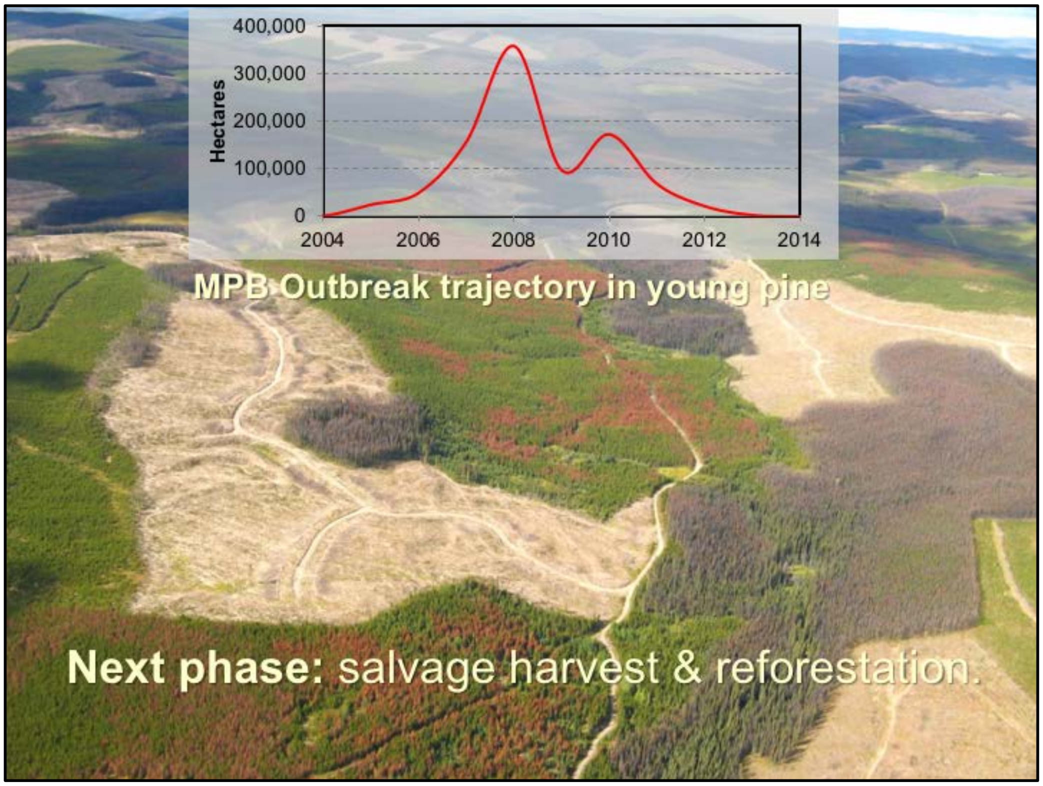
Forests are shaped, regenerated due to these influences.



Climate, aging forests, lack of strategic stand tending or a focused long-term management vision has in part fueled and exacerbated these landscape level events.

In recent decades we have been saying more & more often, “the biggest’, the worst, the most devastating . . .

First came the MPB outbreak, lasting over 15 years and killing 18 million hectares

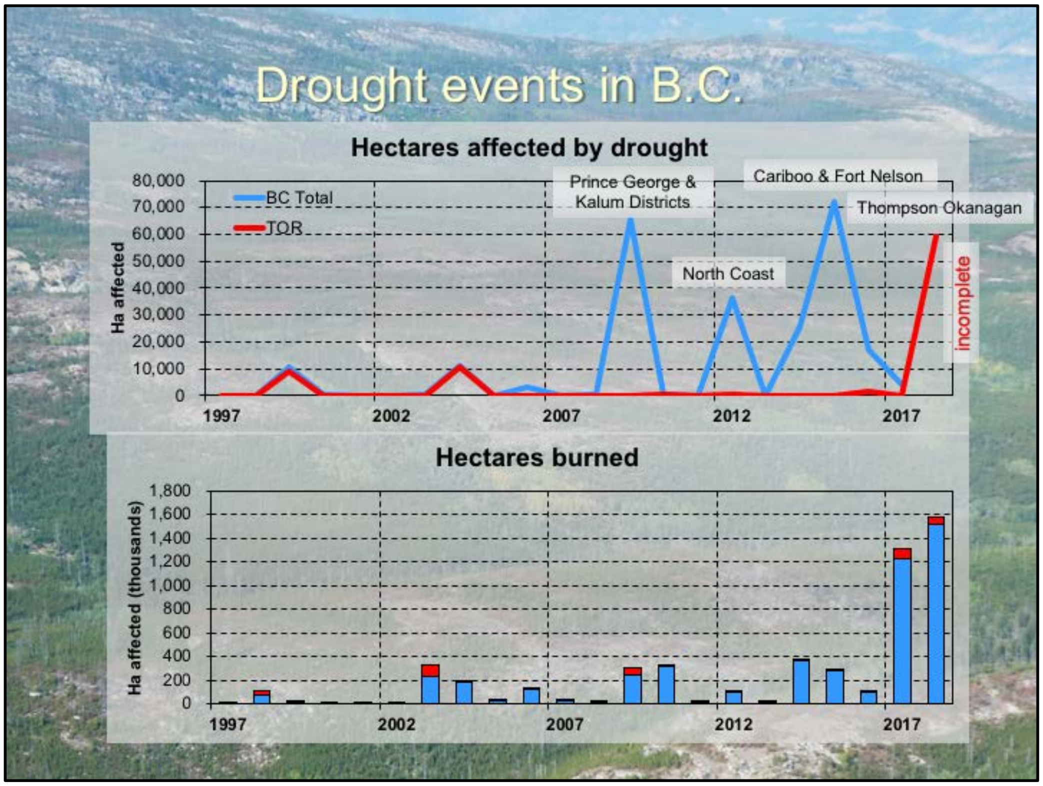

400,000
300,000
200,000
100,000
0
Hectares
2004
2006
2008
2010
2012
2014
MPB Outbreak trajectory in young pine
Next phase: salvage harvest & reforestation.


2017 & 2018: record breaking wildfires in central & southern B.C.

2017 Elephant Hill Fire

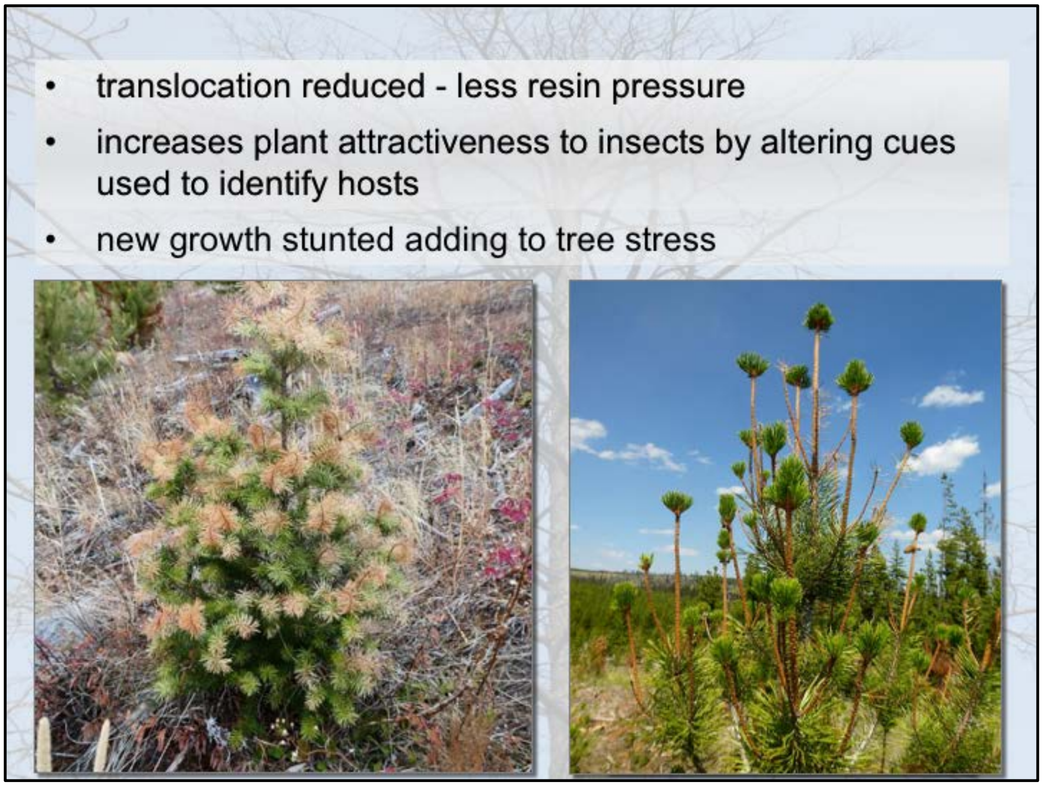
Mature forests, dead forests (Pl), newly planted and young stands affected.


2017: severe drought throughout southern B.C.
2° insect attack



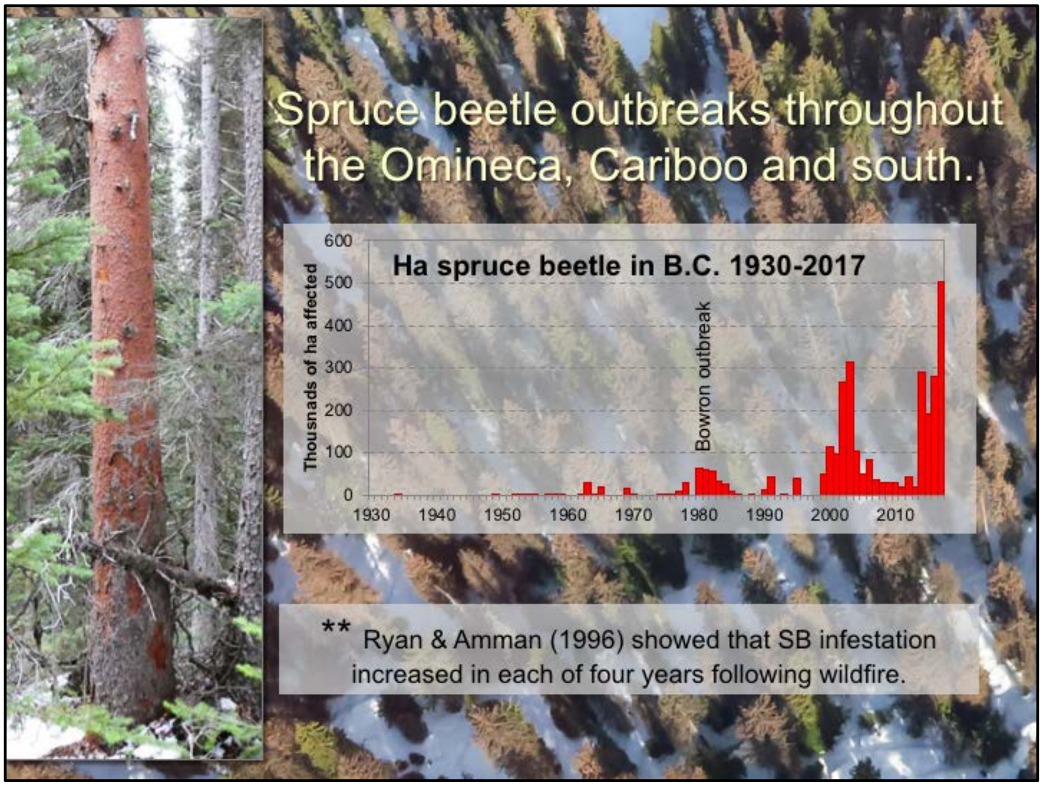
2017 was a particularly bad drought year in the southern interior with >59,000 ha in the TOR alone (primarily mortality). Aerial surveys are still not complete for the rest of the province but drought was observed in the Kootenay Boundary, Cariboo & beyond.

Drought mapping is now divided into mortality and drought stress. Past years on the graph combine these two categories so may tell a bit of a different story. It does seem like drought events are more frequent and severe – and hit in various areas of the province.



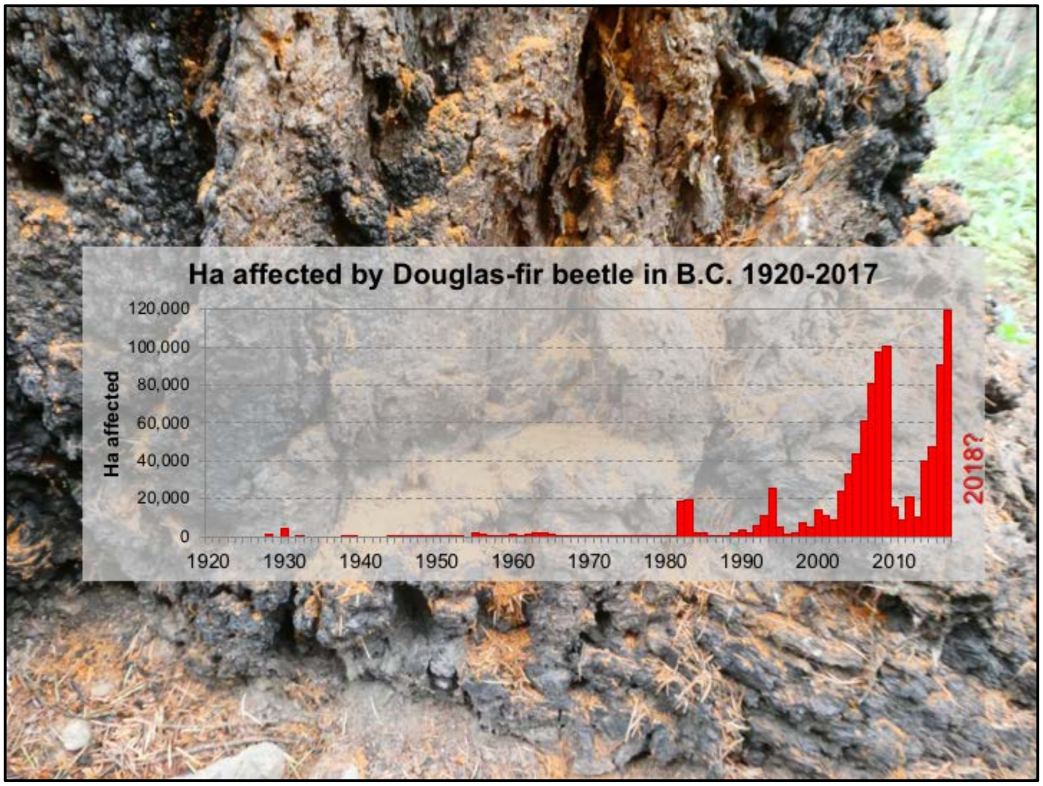
Many more stands than mapped in the Aerial Overview Survey flights were affected by the 2017 drought.
1,600 young stands were aerially surveyed (ages 10-60 years) to determine the **percent area of stands affected by drought**.

- translocation reduced - less resin pressure to expel attacking bark beetles
- Drought can increase plant attractiveness to insects by altering clues used to identify hosts
- New growth stunted adding to trees stress

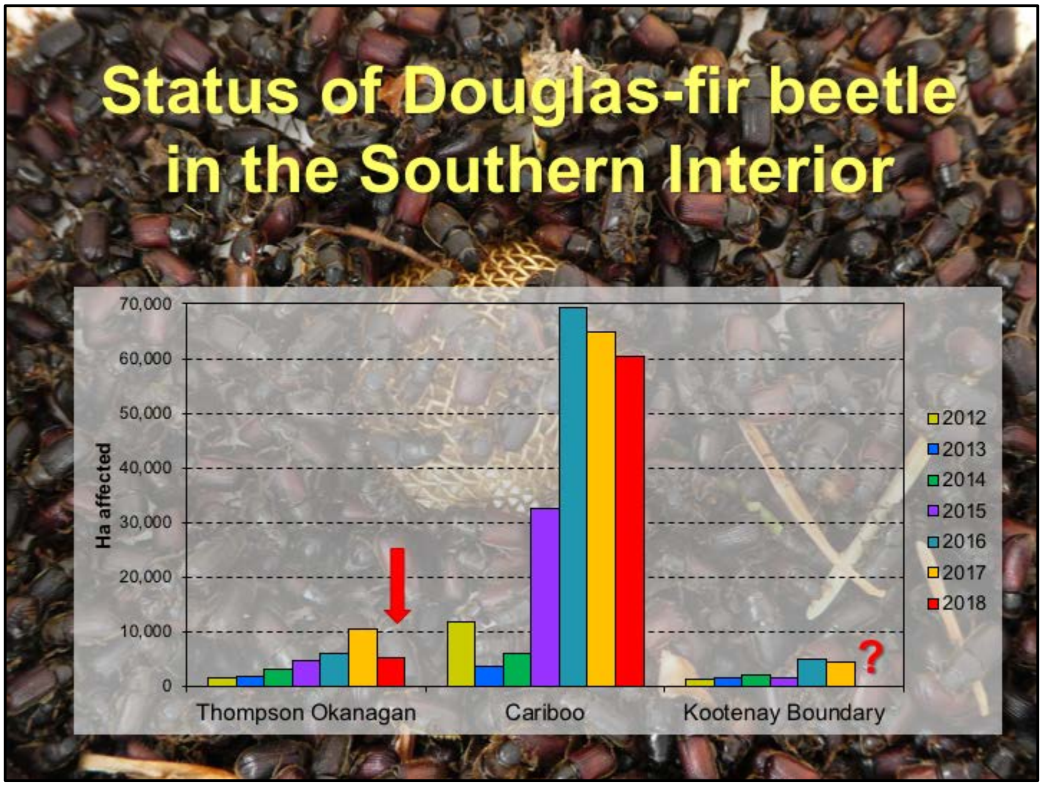


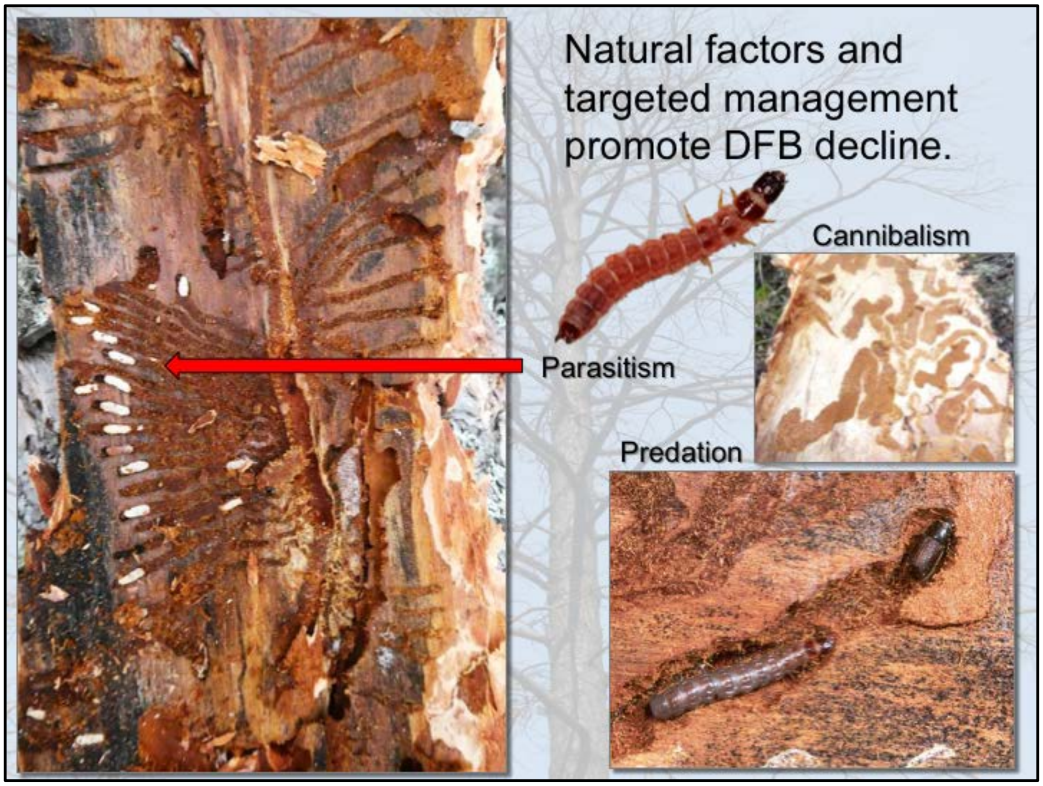
Spruce beetle outbreaks throughout the Omineca, Cariboo and south.
Ha spruce beetle in B.C. 1930-2017
Thousnads of ha affected
600
500
400
300
200
100
0
1930
1940
1950
1960
1970
1980
1990
2000
2010
Bowron outbreak
** Ryan & Amman (1996) showed that SB infestation increased in each of four years following wildfire.

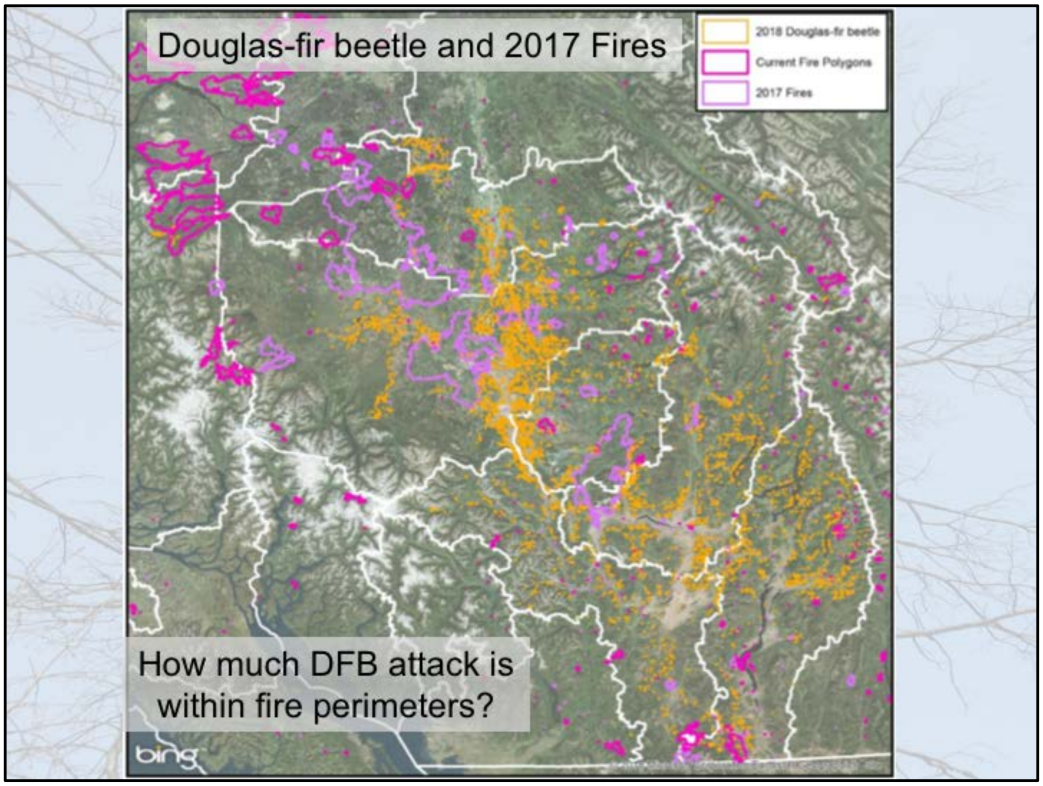

Douglas-fir beetle in outbreak throughout south and central B.C.



Ha affected by Douglas-fir beetle in B.C. 1920-2017
Ha affected
120,000
100,000
80,000
60,000
40,000
20,000
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2018?

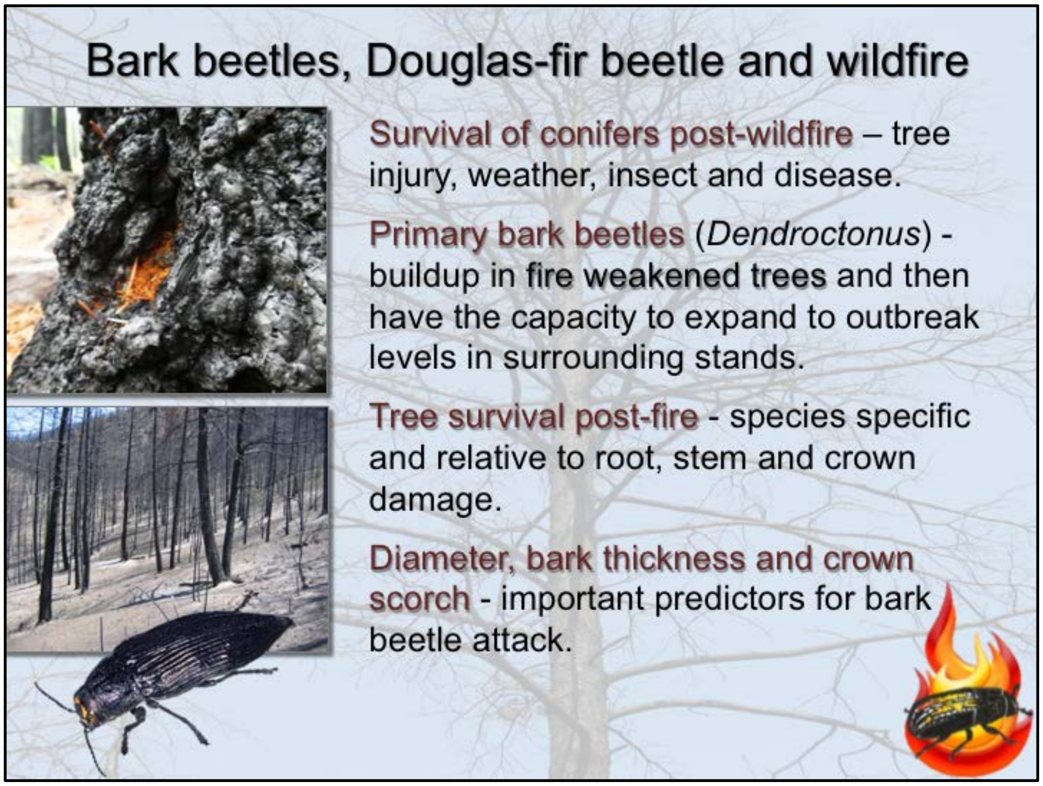

Status of Douglas-fir beetle in the Southern Interior
Ha affected
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Thompson Okanagan
Cariboo
Kootenay Boundary
2012
2013
2014
2015
2016
2017
2018
?


Natural factors and
targeted management
promote DFB decline.
Cannibalism
Parasitism
Predation


Douglas-fir beetle and 2017 Fires
2018 Douglas-fir beetle
Current Fire Polygons
2017 Fires
How much DFB attack is within fire perimeters?
bing

2. Bark beetles and wildfire

One year after the 2017 fires . . . more fires in 2018. Post-wildfire bark beetle implications?



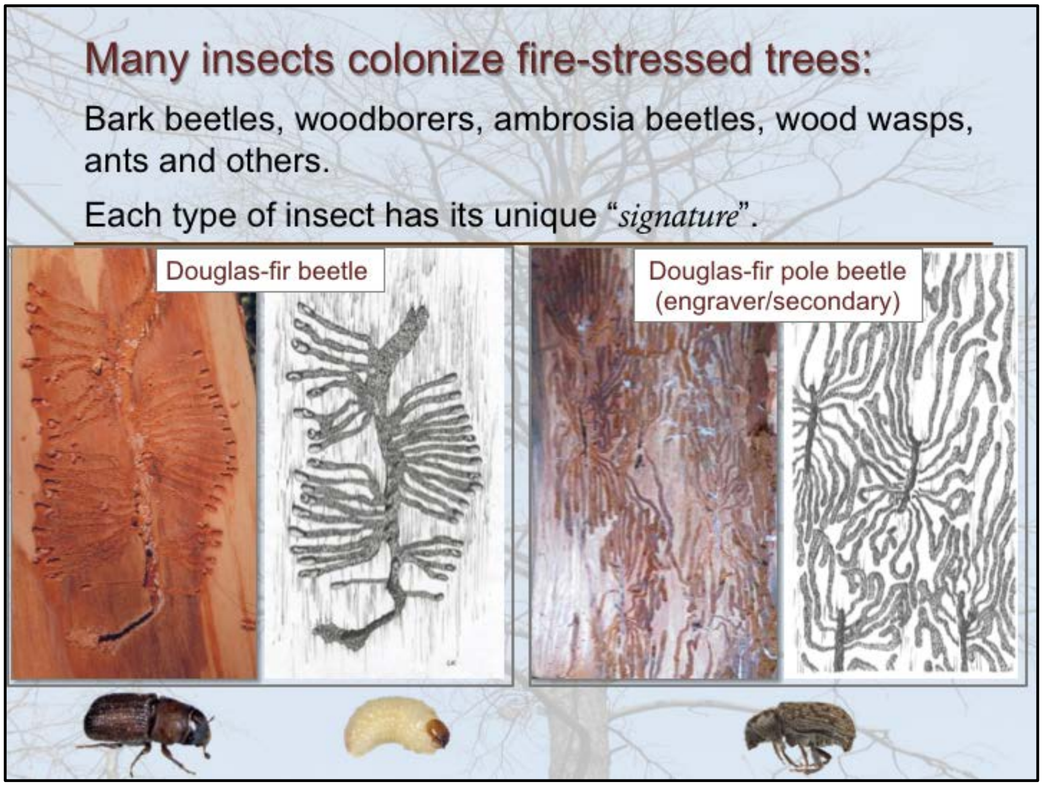
Survival of conifers following wildfire depends on the type and degree of injuries sustained and the post-fire environment, including:

- weather
- stand attributes
- insect (wood borers, bark beetles) and disease population dynamics.

Of particular concern to forest managers are the primary bark beetle species (*Dendroctonus*) which have <u>the capacity to expand to outbreak levels</u> in surrounding stands following buildup in fire weakened trees.

Increased resin does not protect trees from death due to beetle attack.

• It is unclear whether resin chemistry changes as a result of fire. Beetles may home in on resin volatiles post-fire, to find and attack trees.



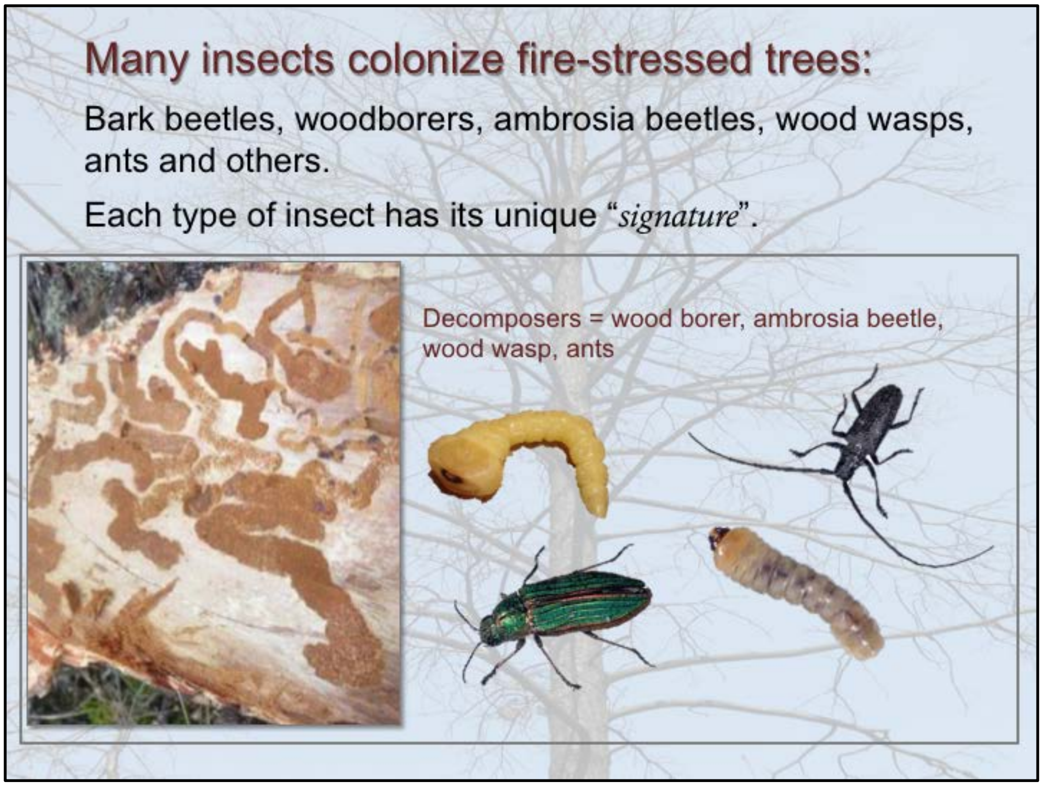
Many insects fire-stressed trees:

Bark beetles, woodborers, ambrosia beetles, wood wasps, ants and others.

Each type of insect has its unique "*signature*".

The there must be sufficient undamaged inner bark (phloem) for beetles to colonize - except ambrosia beetles that spend most of their life cycle in the sapwood.

Secondary bark beetles can kill fire damaged trees similar to DFB, but do not subsequently spread to green, healthy trees.



Many insects fire-stressed trees:

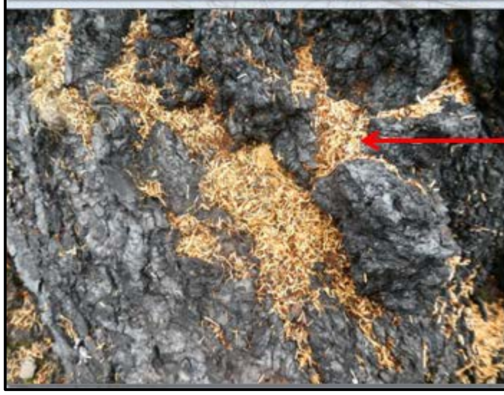
Bark beetles, woodborers, ambrosia beetles, wood wasps, ants and others.

Each type of insect has its unique "*signature*".

And, the there must be sufficient undamaged inner bark (phloem) all species except ambrosia beetles spend part or all of their life cycle in the phloem.

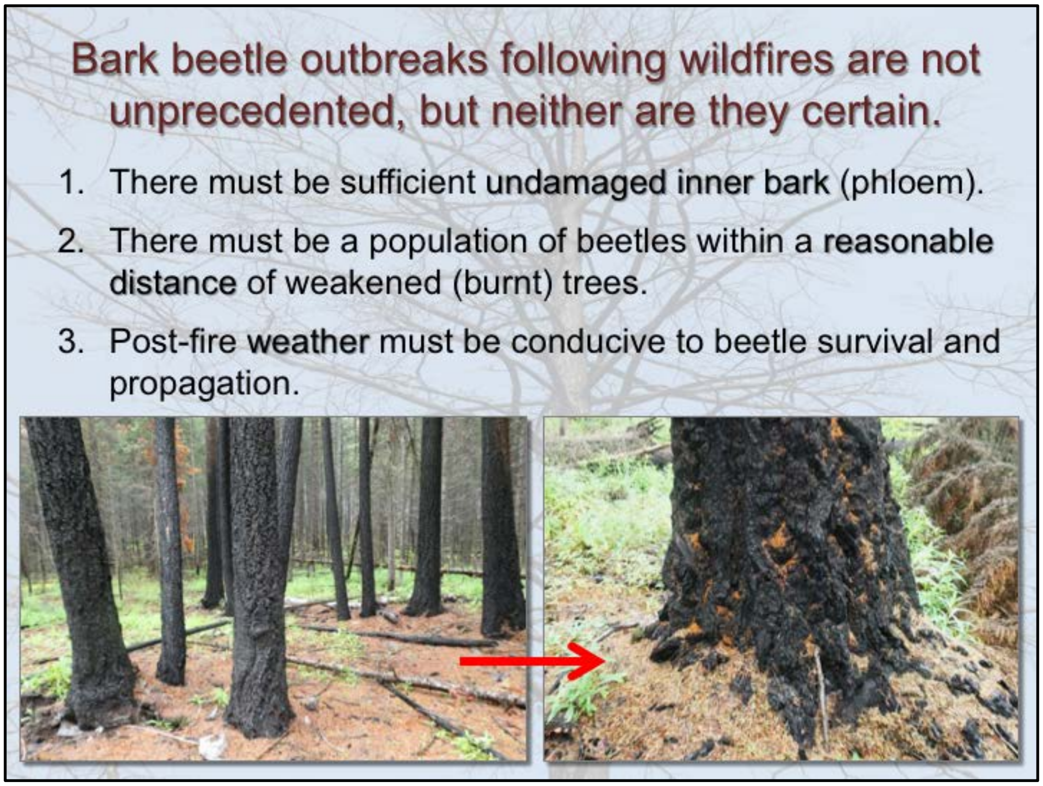
Ambrosia beetle attack

- characterized by fine, white sawdust
- create galleries in the sapwood and stain wood



Wood borer attack

- characterized by shredded wood chips
- wood borers cannibalize bark beetle larvae and occupy prime real estate (phloem) where barks beetles create galleries



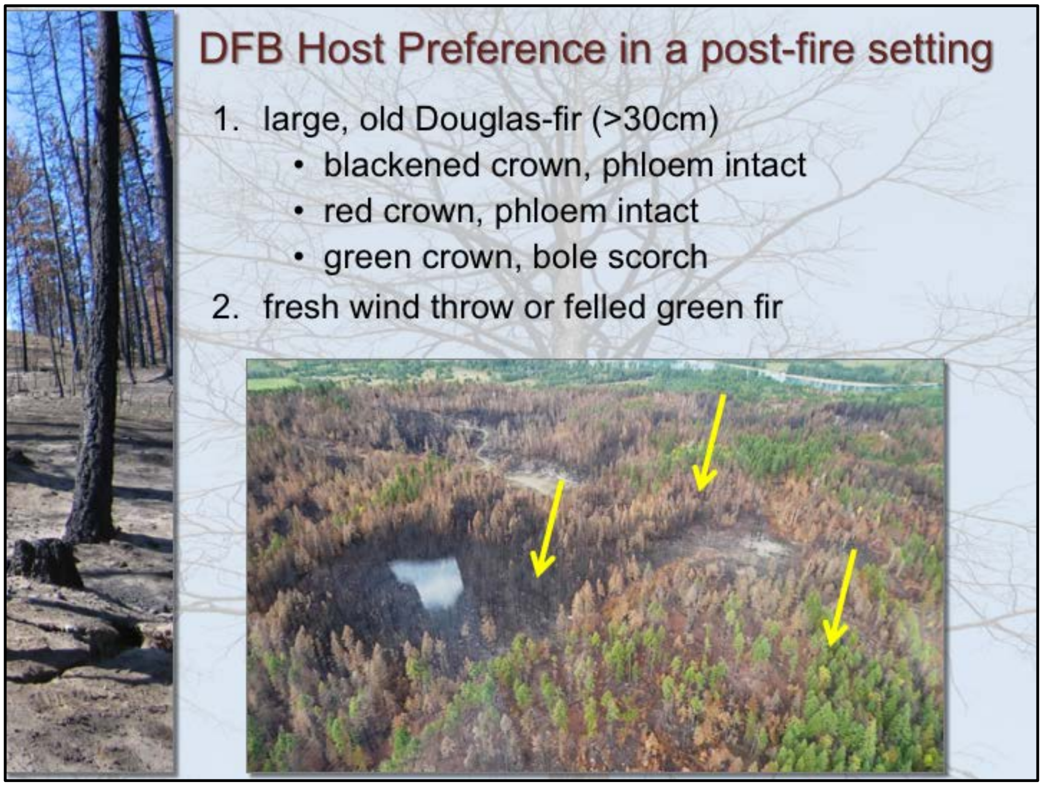
Bark beetle outbreaks following wildfires are not unprecedented, but neither are they certain. Several conditions must exist for bark beetles to take advantage of fire-damaged hosts:

1. There must be a sufficient supply of undamaged inner bark in fire-affected trees. If beetles' food supply, the bark and inner bark (phloem), becomes dry or scorched—often the case in stand-replacing fires or in thin-barked tree species - beetles will neither feed nor lay eggs in it.

2. Fires must occur at a time when beetles either are, or soon will be, in the adult stage and capable of infesting susceptible trees. Fires in late summer or early fall may occur after beetles have flown or may be colonized by wood borers and may therefore not be as suitable to bark beetles the following year. A recently killed tree's inner bark remains usable to beetles for a relatively short time. If not attacked while still "green," phloem may become too dry or otherwise unusable before the next flight season.

3. There must be a population of beetles within a reasonable distance to take advantage of weakened trees which become available.

4. Post-fire weather must be conducive to beetle survival and propagation.



DFB Host Preference in a post-fire setting

1. large, old Douglas-fir (>30cm)
    - blackened crown, phloem intact
    - red crown, phloem intact
    - green crown, bole scorch
2. fresh wind throw or felled green fir

The key to effective management is understanding the beetles **preferred host**, what your landscape looks like (is composed of = HAZARD) and **where** the beetle population is located.

Why do DFB prefer burnt trees? How beetles find scorched and dying trees.

1. Dead and dying fir and spruce produce seudenol that attracts beetles
2. High quantities of oleoresin (alpha-pinene, camphene, and limonene) released from scorched trees.
3. Scorched trees have minimal resistance to DFB – resin response to attacking beetles is <u>not</u> present in burnt trees
4. Yellow and/or red foliage emit greater levels of terpenes than green foliage (or green-infested foliage)
5. DFB can utilize bole and large lateral roots – whereas attack on green trees occurs from ~2m up the tree
6. Secondary flight results in successful brood galleries – whereas typically in the second (later) flight beetles <u>fill-in</u> on downed trees or trees only partially attacked in first peak flight.

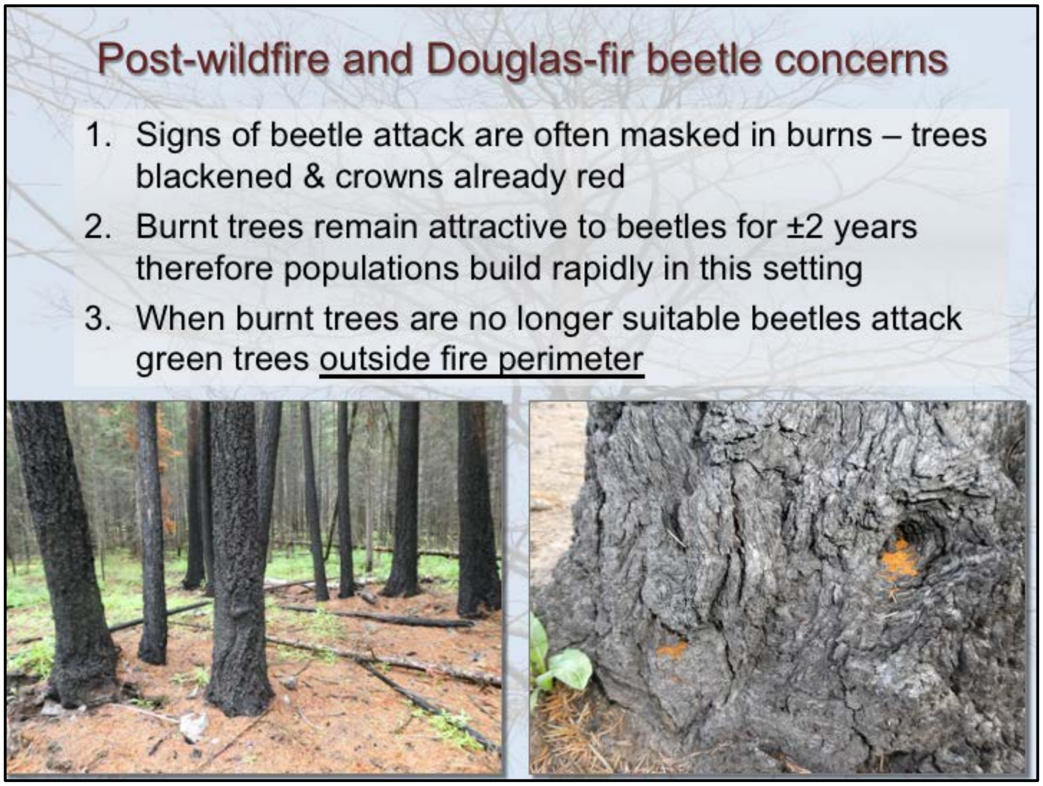
Implementing management strategies for impacted landscapes entails an understanding of bark beetle-wild fire interactions and *erratic* climate.

Landscape events impact population dynamics of bark beetles, which in turn can cause tree injury/death;

** Determine your management approach at the landscape level with **all partners involved.**

Ensure **high priority DFB** is addressed through targeted treatments, timing and harvesting for **maximum effect**.

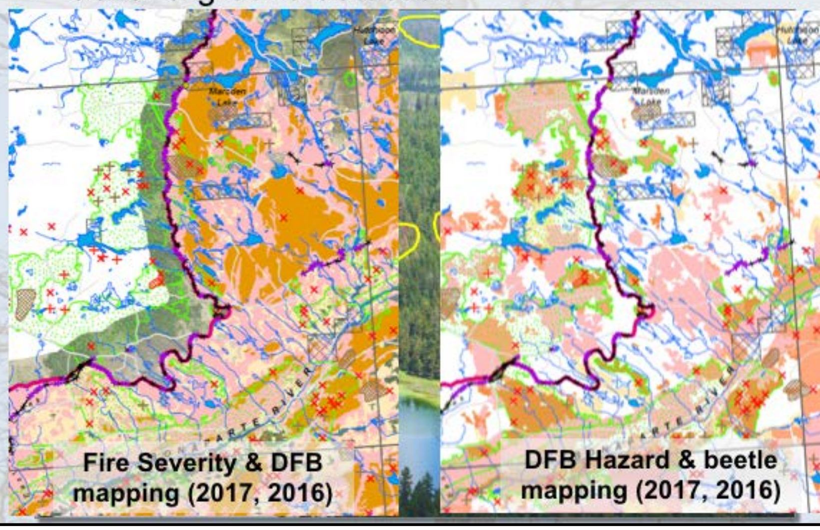
Choose your battle ground!

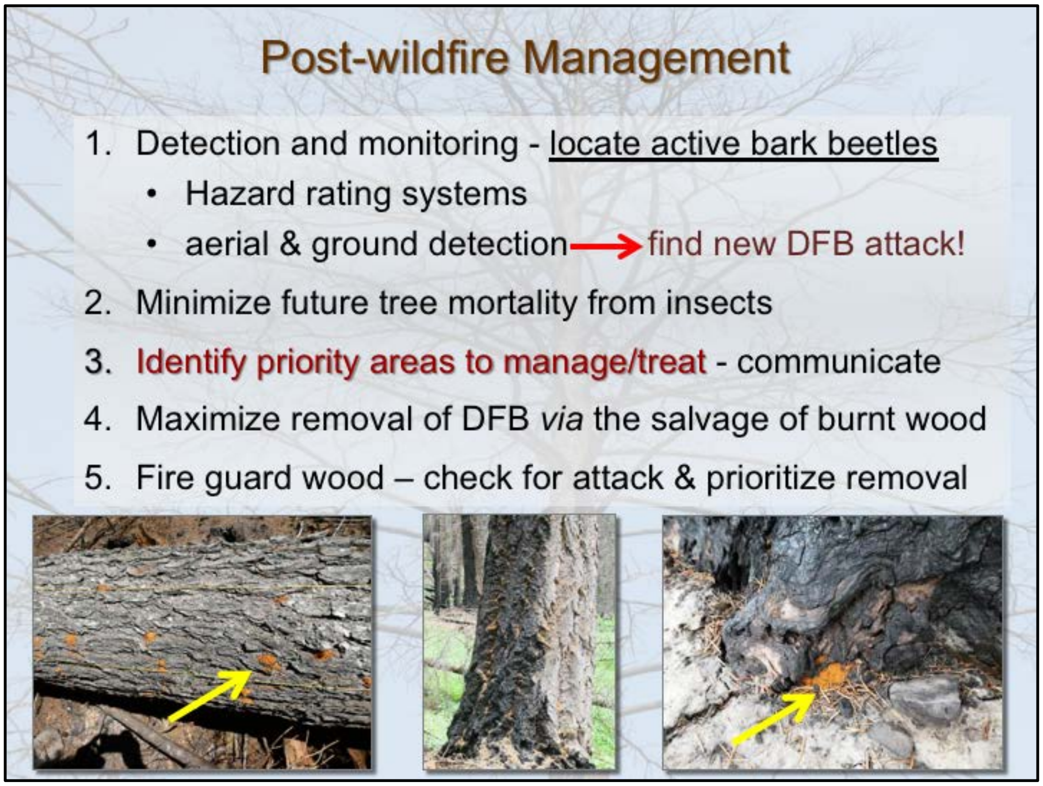


1. Signs of beetle attack are often masked in burns – trees blackened & crowns already red
2. Burnt trees remain attractive to beetles for ±2 years therefore populations build rapidly in this setting
3. When burnt trees are no longer suitable beetles attack green trees <u>outside fire perimeter</u>

Post-wildfire Management

1. Detection and monitoring - locate active bark beetles
   - Hazard rating systems (MFLNRORD provide)
   - aerial & ground detection



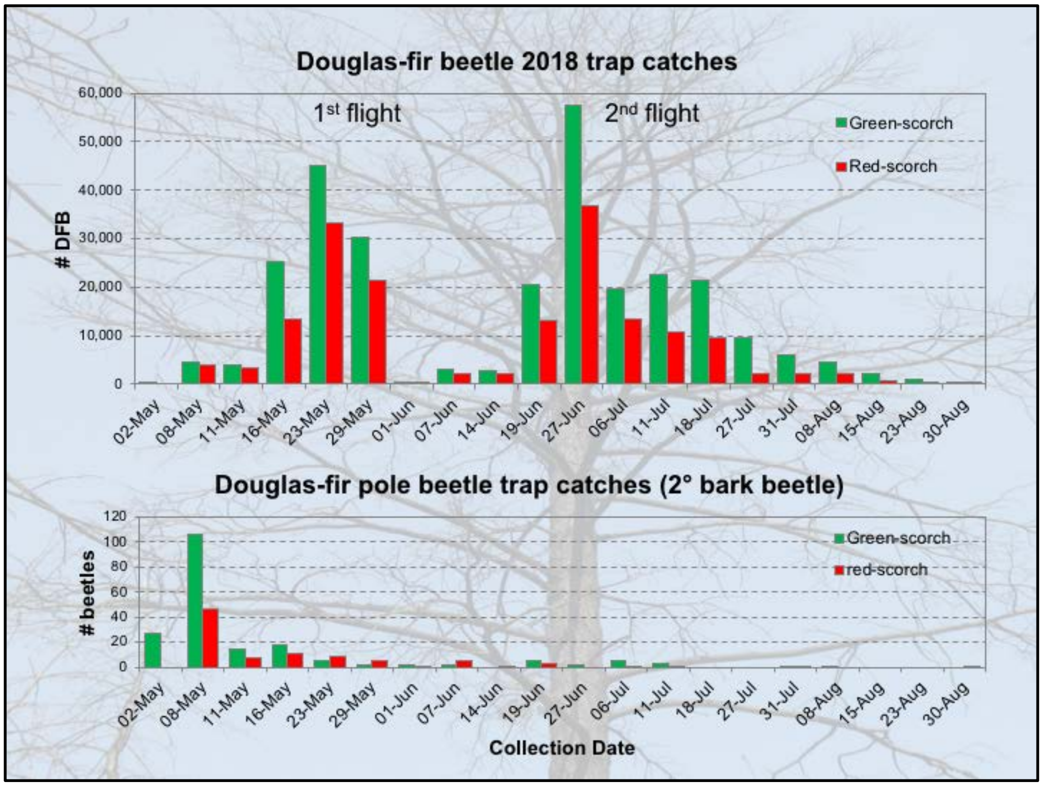


Post-wildfire Objectives & Management

1. Detection and monitoring - locate active bark beetles
    - Hazard rating systems
    - aerial & ground detection
2. Minimize future tree mortality from insects
3. Clearly identify priority areas to manage/treat
4. Facilitate maximum removal of DFB *via* the salvage of burnt wood
5. Fire guard wood – check for attack & prioritize removal
6. DFB select large trees - optimize harvest based on ecosystem-beetle-regeneration priorities
7. Utilize scorched trees to attract DFB – funnel traps**, tree baits
8. MCH (methylcyclohexenone) – can protect live, green trees from DFB in *special* or *constrained areas*
9. Monitor DFB flight period in priority salvage areas

Post-wildfire Management

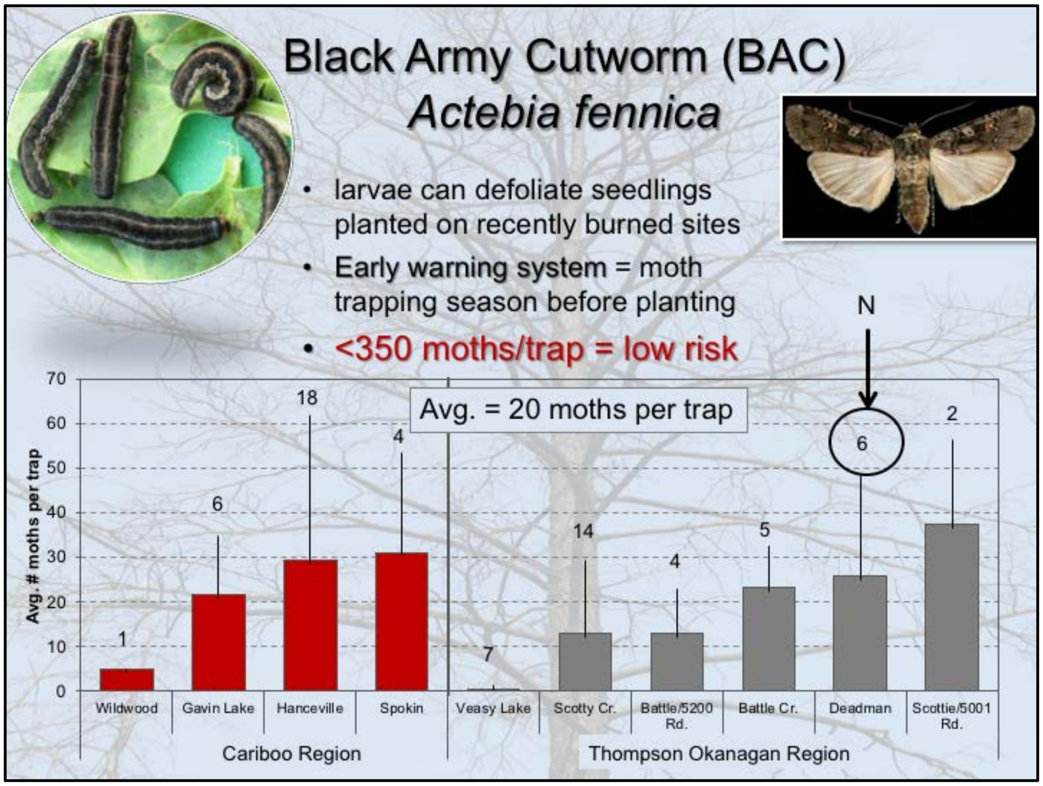
6. DFB select large trees - optimize harvest based on ecosystem-beetle-regeneration priorities
7. Utilize scorched trees to attract DFB – funnel traps, tree baits, green-scorch trap trees
8. MCH (methylcyclohexenone) – can protect live, green trees from DFB in *special* or *constrained areas*
9. Monitor DFB flight period in priority salvage areas



No difference in early trap catches of the 1st and 2nd flights in green- or red-scorch scenarios. However, once overflow attack on trees commences, trap catches are higher in green-scorch scenario.

First and second flight both large.

1. Regeneration issues – black army cutworm
2. Pests of young stands
3. Drought & secondary insect attack



Number above Standard Error bars is “N” – number of sites

A total of 67 traps were established in the two regions.
Overall average trap catch = 20.5 moths/trap (27 avg. in Cariboo; 15 avg. in Thompson Okanagan)

Pest of young stands are influenced by:

- Drought – severity, successive years and location
- species composition (pure stands *vs.* Mixed species stands
- density management (at regeneration; spacing)
- silviculture treatments (pruning; fertilization)

- Climate, fire, insects – interact ~ cumulative
- Woodlots – don’t live on an island; collaborate & communicate with neighbors (beetles will)
- Use all the tools – hazard rating, fire severity, beetle mapping, trap trees, funnel traps, baits
- Young stands – post-free growing years are critical, set them up for success.


Thank you.
Questions?

This year's theme, *From Adversity Comes Inspiration*, puts an emphasis on the 2017 wildfires, what happened in the Cariboo/Chilcoltin and why, plus what can be done to prevent a re-occurrence around other communities.

20 minutes
Absolutely spot on with insects' response to triggers with a focus on wildfires.

Suggestions:
Some thoughts or advice on what WLs should do and watch for post wildfires? Susceptibility of fire stressed trees. Prompt recovery of fire guard wood or plan to use them for trap trees? Importance of monitoring adjacent and nearby stands.

Key insects that could affect post fire regeneration; e.g. I remember we had an unbelievable black army cutworm epidemic after the Canal Flats fires (years ago). They were so thick it looked like the ground was moving and they squished over my boots with every step. Damn things ate 'everything' including trees that survived and first year regen.

Mention that young regenerating stands, particularly pine, aren't immune from insects? Maybe a quick mention of some of the key insects. Get people thinking about the future? FYI, this is a pet peeve of mine. I don't think we pay enough attention to young forests; i.e. from the time they reach free growing to harvest.

Raffa and Berryman 1987
Erbilgin and Raffa 2000
Martin et al. 2003
Gershenzon and Dudareva 2007
Smith 1965
Reid and Gates 1970
Keeling and Bohlmann 2006
Brattli et al. 1998
Seybold et al. 2000
Gray et al. 2015
Paine et al. 1997
Lewinsohn et al. 1994
Giunta et al. 2016
Franceschi et al. 2005
Raffa et al. 2005
Gray et al. 2015
Heikkenen et al. 1965
Schroeder 1988
Miller and Rabaglia 2009
Negron et al. 2001
Furniss 2014
Gibson & Negron 2009
Parker et al. 2006
Hood et al. 2007
Amman and Ryan 1991
Ryan and Amman 1996
Ryan and Reinhardt 1988
Scott et al. 2002
Kolb et al. 1998
Skov et al. 2004
Wallin et al.2004