Forest Insect and Disease Response to Fuels and Silvicultural Treatments

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Ecological Roles of Forest Insects and Diseases

- Organisms discussed today are all native species with important roles in forest ecosystems
  - Promote forest succession
  - Create canopy gaps
  - Source of food for wildlife
  - Breakdown of wood fiber
  - Recycling of nutrients
  - Create snags and down logs that provide wildlife habitat
  - Cause decay and deformities that provide nesting habitat in live trees

Forest Insects and Diseases: Are they an issue for your project?

- Most thinning, mastication and prescribed fire projects are accomplished with few forest insect and/or disease problems
- BUT failure to consider their impacts can lead to unintended negative consequences that interfere with management objectives and can create additional work and expense

It all depends on your management objectives

Which forest insects and diseases are of concern for your projects?

- Bark beetles
- Wood boring beetles
- Dwarf mistletoes
- Root diseases
- Decay fungi

When is the risk of forest insect and disease problems the greatest?

- Drought conditions
- High bark beetle populations
- High levels of disease within or adjacent to project area
- Homogenous forest species composition
- High stand density (pre and post treatment)
- Injuring trees with equipment or Rx fire

Bark beetles

- Bark beetles are ***opportunistic***, infesting trees weakened by other agents or factors
  - Disease infection
  - Infestation by other insects
  - Fire and mechanical injury
  - Drought
  - High stand densities
  - Soil compaction (high use sites or construction)
  - Air pollution

Bark beetles

- Bark beetles produce ***aggregating attractants*** that insure mass attack of suitable host material

These attractants *(pheromones)* also lead to group-killing of trees

Bark beetles

- A ***high reproductive potential*** allows bark beetles to multiply rapidly when conditions are favorable

Important bark beetle species in California

Dendroctonus jeffreyi, Jeffrey pine beetle (JP)

Dendroctonus brevicomis, Western pine beetle (CP, PP)

Dendroctonus ponderosae, Mountain pine beetle (LPP, PP, WWP, SP, KP, WBP)

Dendroctonus pseudotsugae, Douglas-fir beetle (DF)

Dendroctonus valens, Red turpentine beetle (all pines)

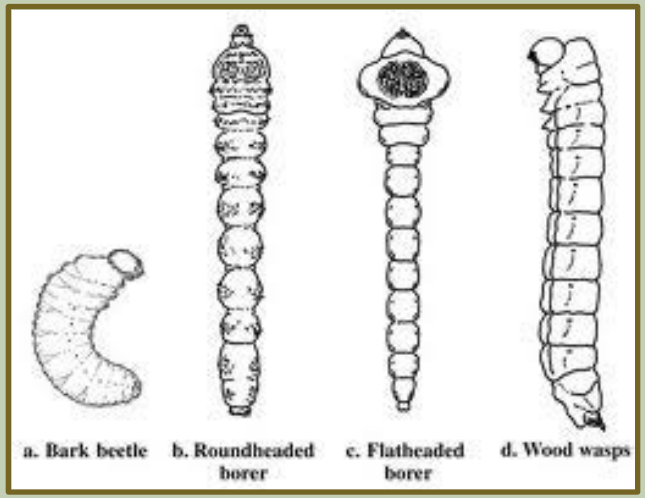
Ips pini, Pine engraver (all pines)

Ips paraconfusus, California five-spined ips (all pines)

Ips confusus, Pinyon ips (pinyon pine)

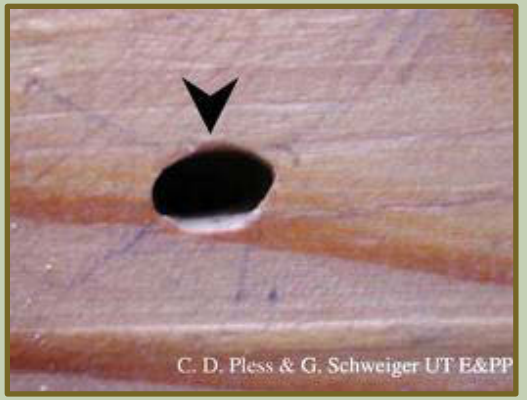
Scolytus ventralis, Fir engraver (true firs)

Wood Borers



Wood Wasps

Buprestids- Metallic Wood Borers



Cerambycids- Longhorn Beetles

Wood Borers

- Some woodboring beetle species can detect smoke approximately 50 miles away with sensors on their antennae

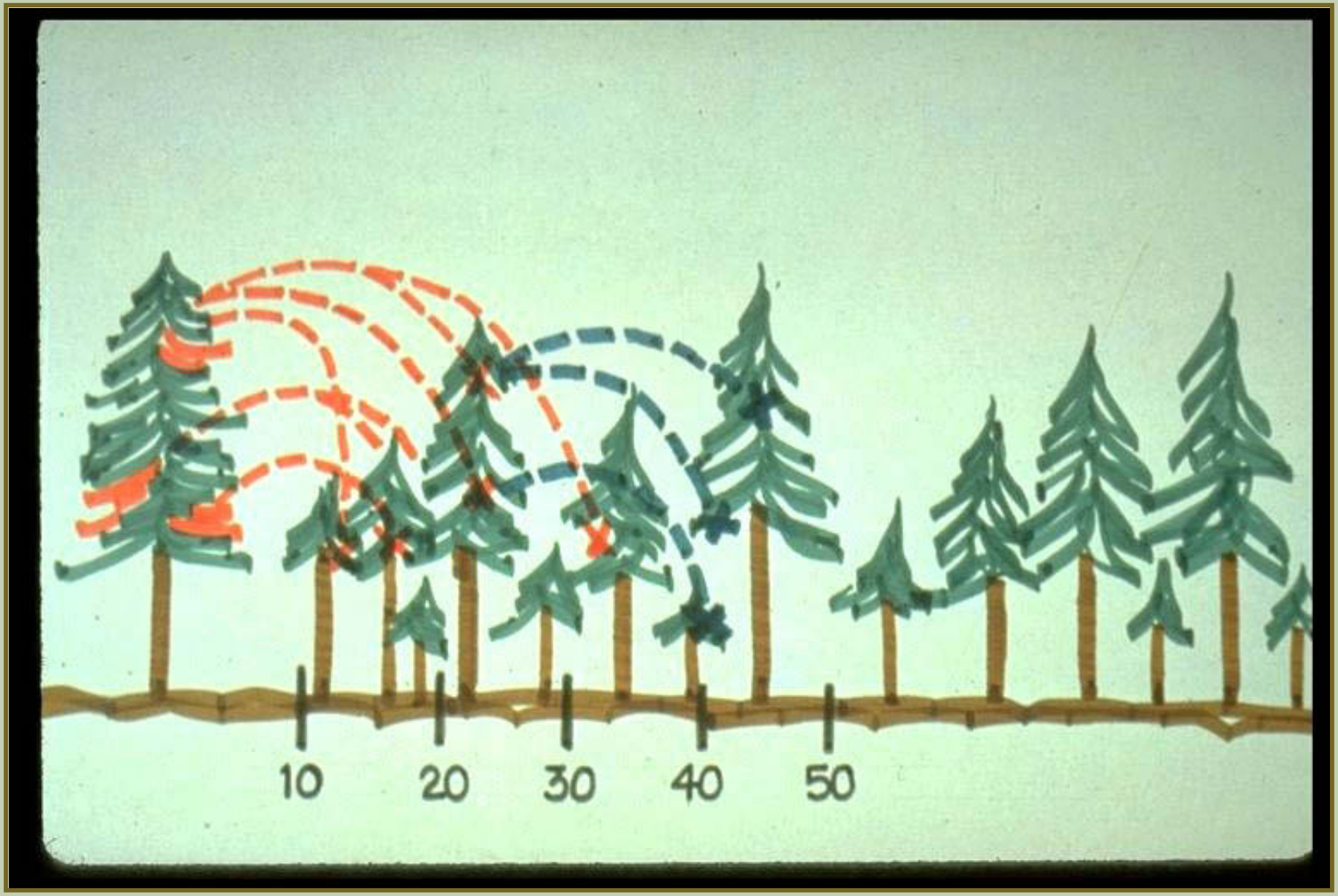
- Some woodboring beetles have special sensors -- sensilla -- in tiny pits on their underside that can actually pick up infrared (IR) radiation from a fire

- Wood wasps can also be seen ovipositing on burnt trees

Dwarf Mistletoes

Spread by Explosive Seed Dispersal

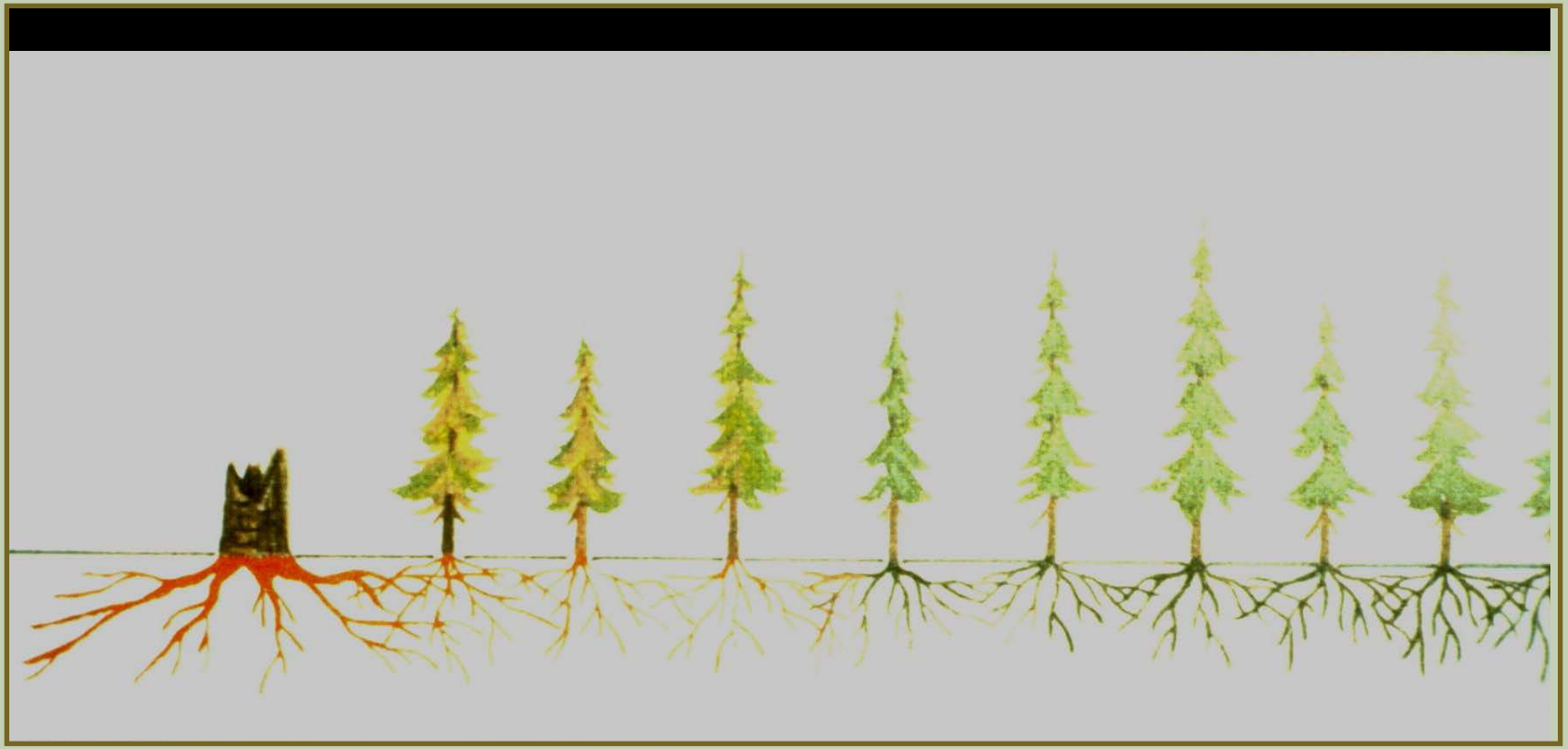
Dwarf Mistletoe



Dwarf Mistletoes

- Growth Reduction
- Mortality
- Growth Abnormalities
- Predisposition to Other Pests (Bark Beetles, Cytospora Canker)

Root Diseases



Infected Roots

Healthy Roots

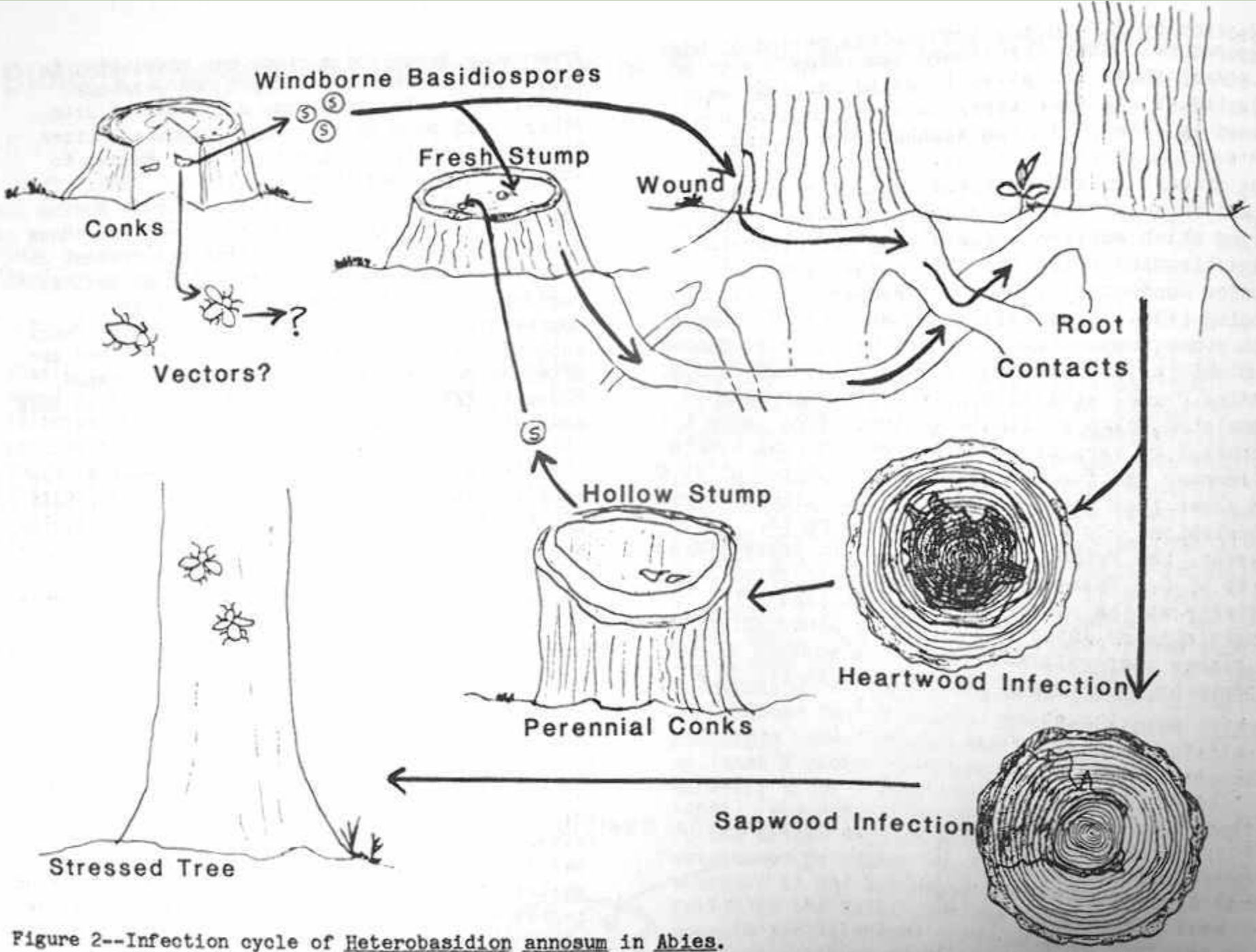


Figure 2--Infection cycle of Heterobasidion annosum in Abies.

Root Diseases

- Tree mortality
- Growth reduction
- Tree stress
- Tree hazard
- Long-term management problem

Stem decay fungi

- Make timber unmerchantable and reduce wood quality
- Can make trees hazardous

Eastside Pine and Eastside Mixed Conifer

- Heterobasidion root disease
- Black stain root disease
- Western dwarf mistletoe
- True fir dwarf mistletoe
- Pine engraver beetle (*Ips pini*)
- Western, mountain, Douglas-fir and Jeffrey pine beetles
- California flatheaded borer
- Fir engraver beetle
- Flatheaded fir borer

Westside Mixed Conifer

- Heterobasidion root disease (true fir)
- True fir dwarf mistletoe
- Stem decays in true fir associated with mechanical and fire injuries
- Fir engraver beetle
- Mountain pine beetle in sugar pine

Westside Pine

- California fivespined ips (*Ips paraconfusus*)
- Western pine beetle
- Western dwarf mistletoe

Thinning considerations

Conditions that can influence insect and disease activity

- Stand location: site class, microclimate
- Pre and post treatment precipitation
- Timing of treatments
- Mechanical injury to roots and boles (compaction and skidding)
- Release of tree volatiles during harvest

Conditions that can influence insect and disease activity

- Existing disease infections and bark beetle populations
- Residual stand characteristics (density, size and species)
- Creation of green pine slash
- Post-treatment windthrow

Reducing risk of bark beetle-caused tree mortality during thinning projects

- Enhance age and species diversity to reduce total losses
- Stocking control is important for all but youngest age classes
- Fit stocking control level to species requirements in mixed stands
- Sanitation and leaving the “best” trees improves resistance: >35% LCR, disease free, damage free
- Match tree species to site conditions

Bark Beetles

Thinning can reduce susceptibility to bark beetles and reduce hazardous fuels.

May be necessary to thin to lower densities than might be adequate for reducing fuels.

Engraver beetle management

- Engraver beetles breed in fresh pine slash and subsequent generations can attack and kill residual trees

- ***Timing*** of slash creation is critical; the **safe time** for thinning and creating slash is between ***July and December***

Engraver beetle management

- Engraver beetle concerns are greatest on **dry sites** and during **dry years**
- Stacked material is more conducive to population buildup than material that is scattered or crushed

- Material consolidated into large piles at landings has fewer problems
- Host material **<3”** in diameter is not a problem

Pine engraver, *Ips pini*

- Most common in higher elevations and toward east side of Sierras and Cascade Mountains with 2 - 3 generations/year
- During drought periods, pine engravers become a very important mortality agent

California five-spined ips, *Ips paraconfusus*

- More common west of the Sierras and Cascades and in Coast Range
- ***Four*** generations per year
- Slash management is most critical for this species of engraver

Dwarf Mistletoe

-Manage for Seed Interception

- Increase Spacing Between Trees
- Maintain a Mixed Species Stand (Host Specificity of Dwarf Mistletoes)

-Remove severely infected overstory trees

-Favor non-host trees

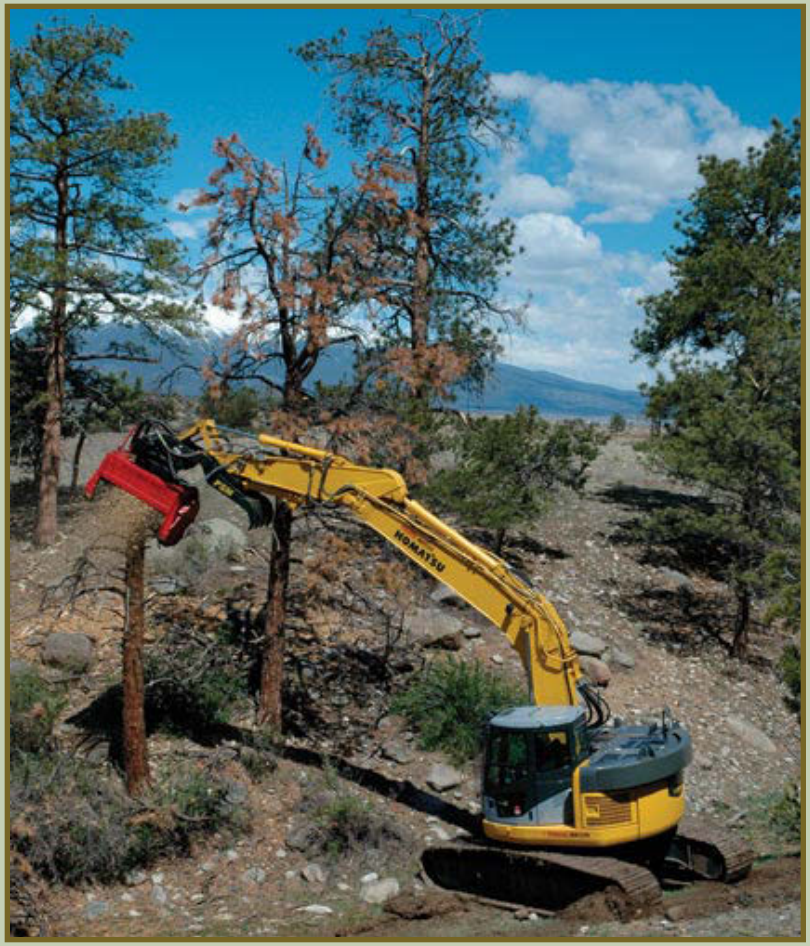
Dwarf Mistletoe

- Ponderosa pine and Jeffrey pine with dwarf mistletoe are most difficult to manage
  - Alternate species not available
  - Especially on poor growing sites

Dwarf Mistletoe

Improve tree vigor:

- Increase tree spacing
- Promote height growth
- Prune infected branches
- Cut out heavily infested stands



Heterobasidion Root Disease

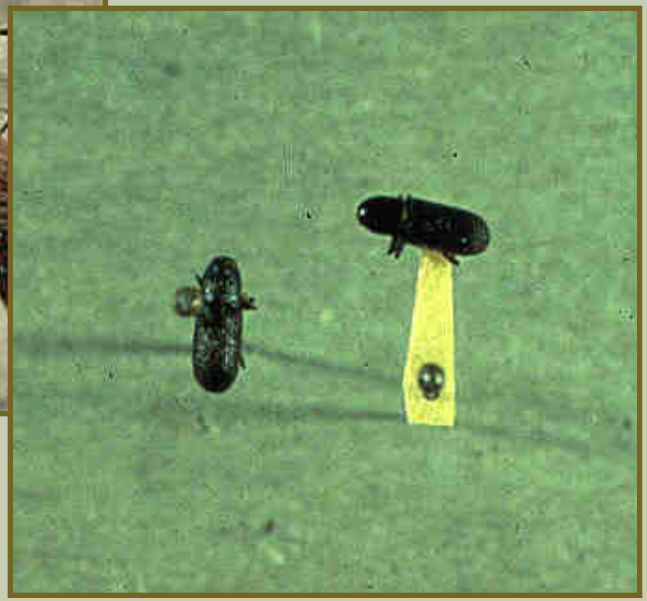
Heterobasidion occidentale (formerly S-type)
Heterobasidion irregulare (formerly P-type)

Heterobasidion Root Disease

Heterobasidion Root Disease

- Retain non-host species
- Provide extra growing space
- Cut out root diseased pockets and replant with non-host species

Black Stain Root Disease



Black Stain Root Disease

Leptographium wageneri

- Main hosts are ponderosa, Jeffrey and pinyon pine and Douglas-fir
- Long distance spread by root feeding beetles; short distance spread via root to root contact
- Minimize soil disturbance and tree injury during thinning operations
- Time thinning when insect vectors are least active (mid to late summer)

Stem Decays

- Manage site disturbance: use designated skid trails, rub trees and directional felling
- Encourage tree vigor, avoid growing true fir to ages older than 100 years
- Avoid wounding, especially in true fir stands
- Remove damaged seedlings and saplings

White pine blister rust

- Non-native pathogen that infects 5-needle pines
- Sugar and western white pines most common in project areas
- Should retain all healthy individuals that appear free of blister rust as they may be genetically resistant to infection

Rx Fire Considerations

Conditions that can influence insect and disease activity

- Stand characteristics (size classes, species, density)
- Fuel levels (ladder fuels, course woody debris and duff and litter)
- Burn conditions (humidity, wind, etc)
- Level of tree injury (crown scorch/kill, cambium kill)
- Release of volatiles
- Timing of burn (spring vs. fall)

Burning masticated material can result in high temps and long residence times over root zones

Fuels next to tree boles can kill cambium, remove bark and provide an entry court for decay fungi

Large old pines can be partially to completely heat girdled by Rx fire

Host Resistance to Bark Beetles

Functions of resin:

Primary defense (physical and chemical) mechanism of conifers

Constitutive resin- created & stored in resin ducts
Induced resin- newly synthesized in response to repeated wounding
Monoterpenes- volatile organic compounds

Resin production is temporarily increased following fire (coincides with increased susceptibility or anticipated vulnerability to bark beetles)

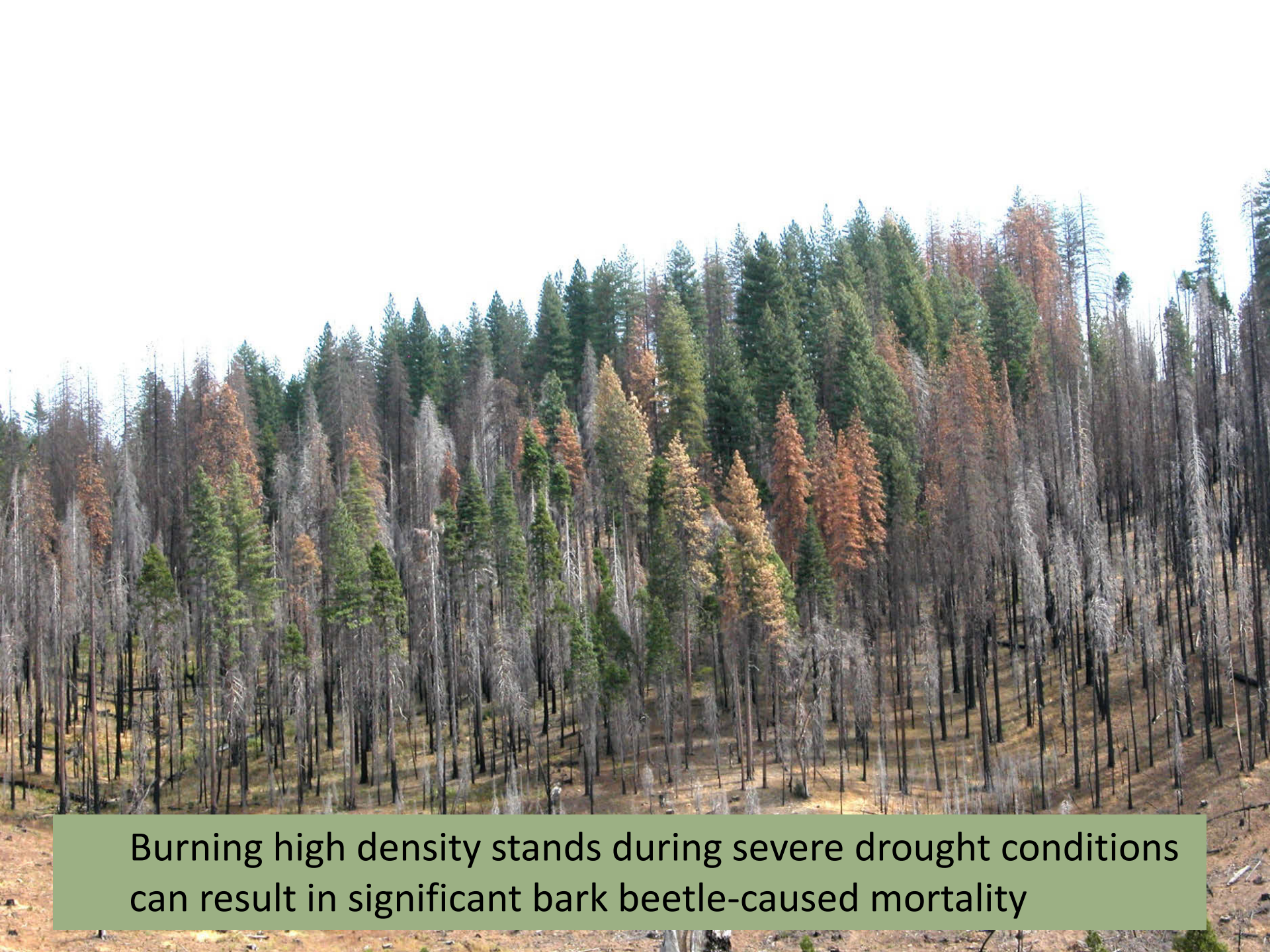
Fire Effects Chemical Resistance & Host Susceptibility

When woody tissues are injured, monoterpenes increase substantially

Exposure of tree tissues to heat stimulates the production of volatile hydrocarbons, especially ethanol (Kelsey and Joseph 2003)

- 1,967 beetles in traps on fire injured trees vs. 70 beetles in traps of un-burned (control) trees
- Quantity of ethanol increases with each level of injury
- Red turpentine beetle preferred fire injured trees over controls

Ethanol is often added to bark beetle pheromones to increase trap catches



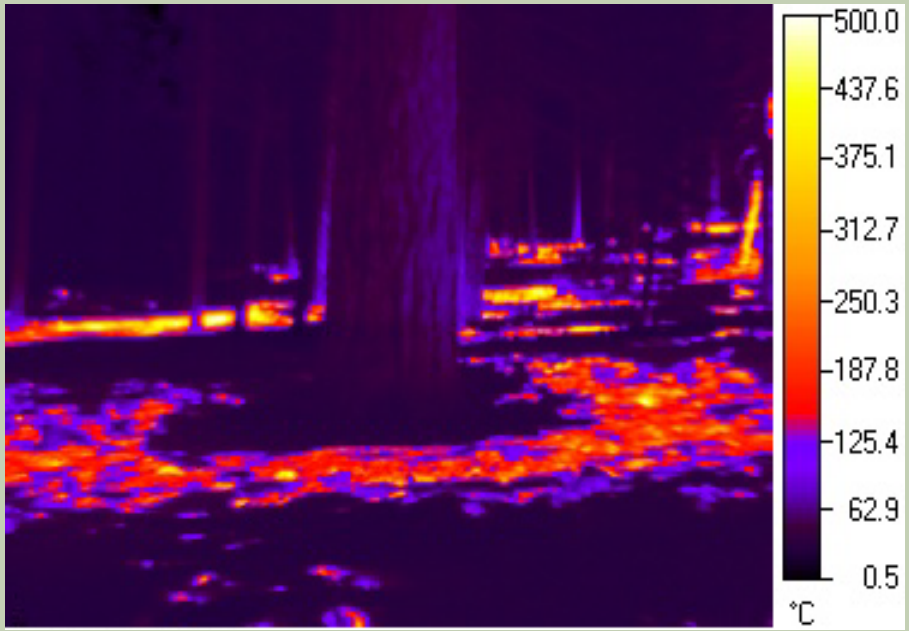
Burning high density stands during severe drought conditions can result in significant bark beetle-caused mortality

Ways to reduce fire-injury to trees

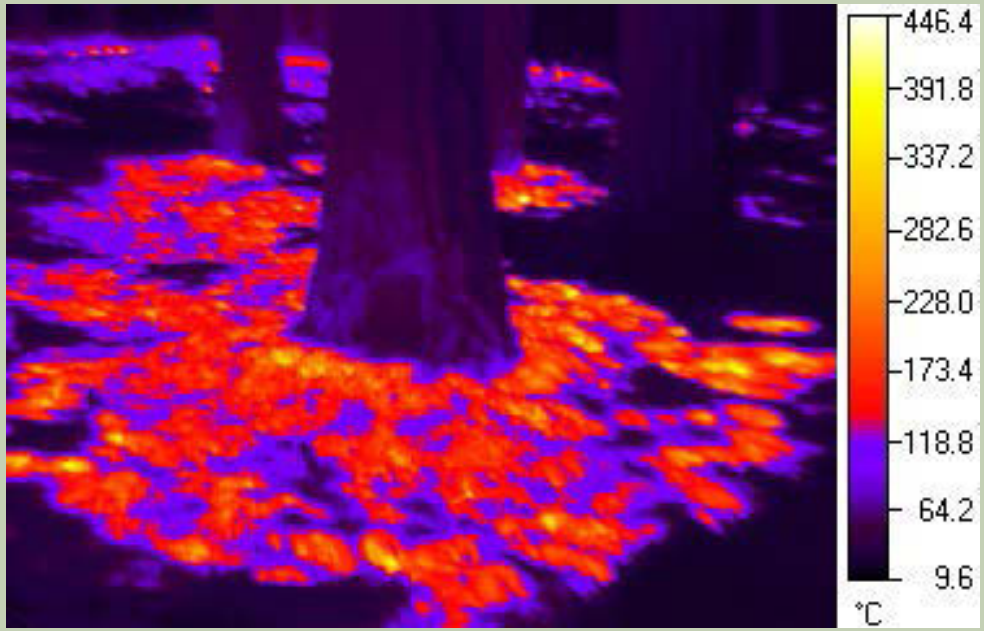
- Pre-commercial thinning and/or mastication of brush and small trees to reduce ladder fuels to reduce crown injury, aim for less than 50% crown scorch/kill
- Grapple piling large woody material to reduce potential for root injury and the amount heat radiating up into crowns (important in white fir stands)
- Minimize the potential for bark beetle activity by not causing excessive injury to trees during spring burns
- Conduct prescribed burns in fall when possible to avoid bark beetle flight periods
- Remove heavy surface fuels, duff and litter from large diameter pines to avoid killing cambium, especially sugar pine

Burning Treatments

Raked Tree



Unraked Tree



Fuels and Silvicultural Treatments: Summary of Recommendations

- Increase stand heterogeneity
  - Species, Age, Size Class
- Reduce stand density
  - Increase growth and vigor of residual trees
  - Increase in constitutive resin defenses
  - Increase in bark beetle resistance
- Select against diseased trees
  - Reduce dwarf mistletoe infection levels
  - Replace root disease pockets with non-hosts
- Minimize fire-injury to trees
  - Pre-treat surface and ladder fuels
  - Reduce stand density before burning

Fuels and Silvicultural Treatments: Things to avoid

- Not reducing stand density enough to increase resilience to bark beetles
- Leaving tree species that are not suited for the site (white fir)
- Injuring trees with logging equipment and/or Rx fire that can lead to bark beetle attacks or disease infections
- Creating green pine slash that can result in a buildup of *Ips* bark beetles and subsequent tree mortality
- Not treating susceptible stumps with registered borate compound resulting in the establishment of new root disease centers
- Leaving a dwarf mistletoe infested overstory that will infect understory trees

Questions ?????