

TREE HEALTH: DROUGHT AND BARK BEETLES

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Image: Mimi Garten



DROUGHT

- Period of unusually persistent dry weather that persists long enough to cause serious problems such as tree stress and/or mortality
- Shortage of water that is driven by an imbalance between supply and demand
- Complex phenomenon
 - Palmer Drought Index
- 4 types
 - Meteorological
 - Hydrological
 - Agricultural
 - Socioeconomic



Drought-Mediated Changes in Tree Physiological Processes Weaken Tree Defenses to Bark Beetle Attack

Thomas Kolb¹ • Ken Keever-Ring² • Stephen J. Burr³ • Richard Hofstetter¹ • Monica Gaylord⁴ • Kenneth F. Raffa⁵



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Observed and anticipated impacts of drought on forest insects and diseases in the United States[☆]

Thomas E. Kolb^{a,*}, Christopher J. Fettig^b, Matthew P. Ayres^c, Barbara J. Bentz^d, Jeffrey A. Hicke^e, Robert Mathiasen^a, Jane E. Stewart^f, Aaron S. Weed^g



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Bark beetle-caused mortality in a drought-affected ponderosa pine landscape in Arizona, USA

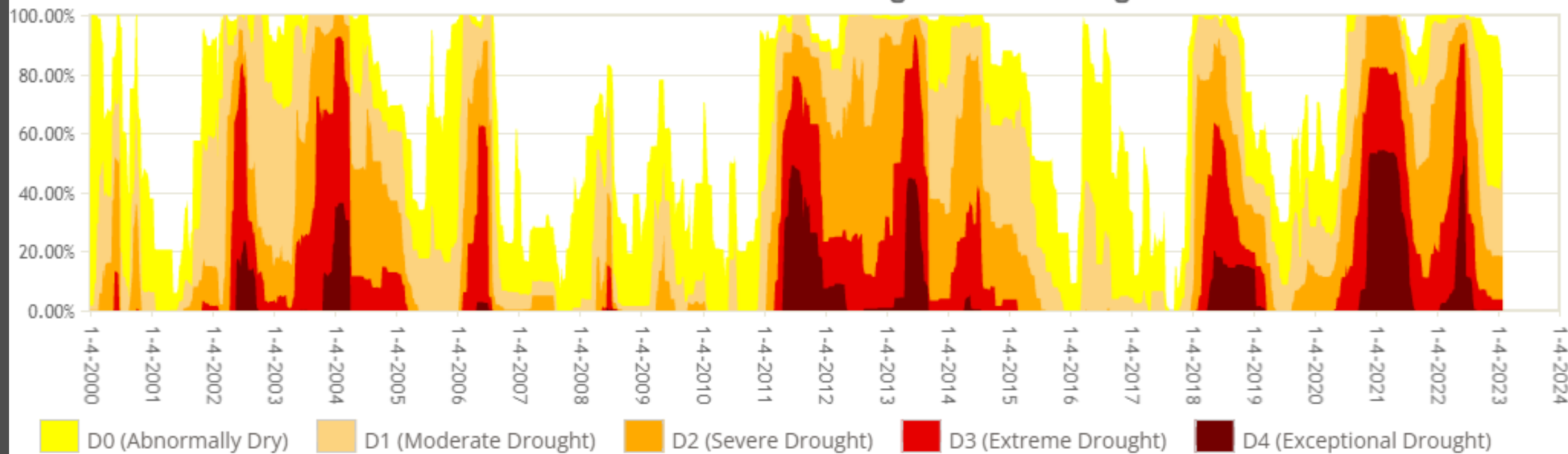
José F. Negrón^{a,*}, Joel D. McMillin^b, John A. Anhold^b, Dave Coulson^c

A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests

Craig D. Allen^{a,*}, Alison K. Macalady^b, Haroun Chenchouni^c, Dominique Bachelet^d, Nate McDowell^e,



New Mexico Percent Area in U.S. Drought Monitor Categories



DROUGHT EFFECTS ON TREES

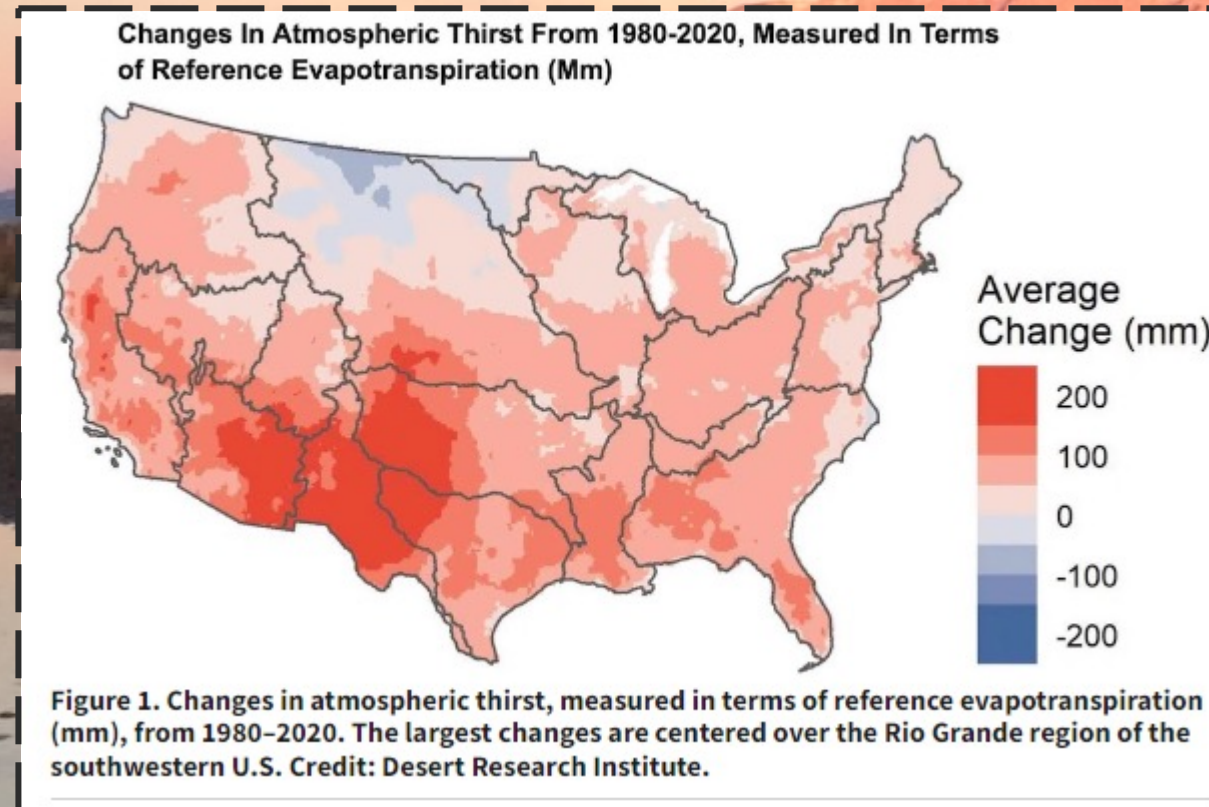
- Decreased growth
 - Photosynthetic changes
- Embolisms
- Leaf scorch/leaf loss
- Greater seed production
- Secondary attacks by insects/pathogens
 - Decreased resin and secondary defensive chemicals
 - Drought-stressed trees emit higher concentrations of volatile chemicals (ethanol and α -pinene)

DROUGHT EFFECTS ON TREES (VOCS)



HEAT EFFECTS ON TREES

- Increased transpiration
 - Increased evaporative demand (i.e. atmospheric thirst)
 - Accelerates water being drawn from the land surface into the atmosphere

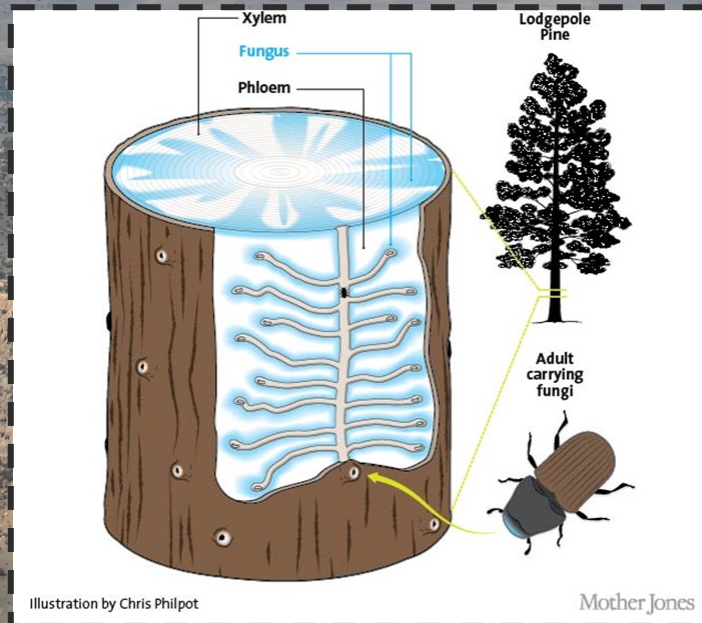


BARK BEETLES



- Insects that live and reproduce within inner bark, phloem, and cambium layers
- Most species colonize dead, dying, damaged, or stressed trees
 - Some species attack and kill “healthy trees”
- Generally kill more forests every year than any other mortality agent
 - Including wildfire

- Most partner with symbiotic fungi
 - Food
 - Helps overwhelm tree defenses



Tree defoliation and mortality attributed to insects and diseases during aerial detection surveys and wildland fire hectares from the U.S. from 2010 to 2016; Coleman et al. 2018.

Year	Tree defoliation	Tree mortality	Wildland fire acres
2016	2,272,362	3,181,556	2,229,818
2015	5,186,028	2,455,854	4,097,506
2014	2,056,414	1,884,043	1,455,094
2013	3,356,311	1,799,650	1,748,060
2012	3,935,594	1,858,643	3,774,198
2011	3,018,089	2,678,335	3,525,368
2010	3,717,912	3,756,306	1,385,128

LEVELS OF BARK BEETLE POPULATIONS



LATENT (aka endemic)

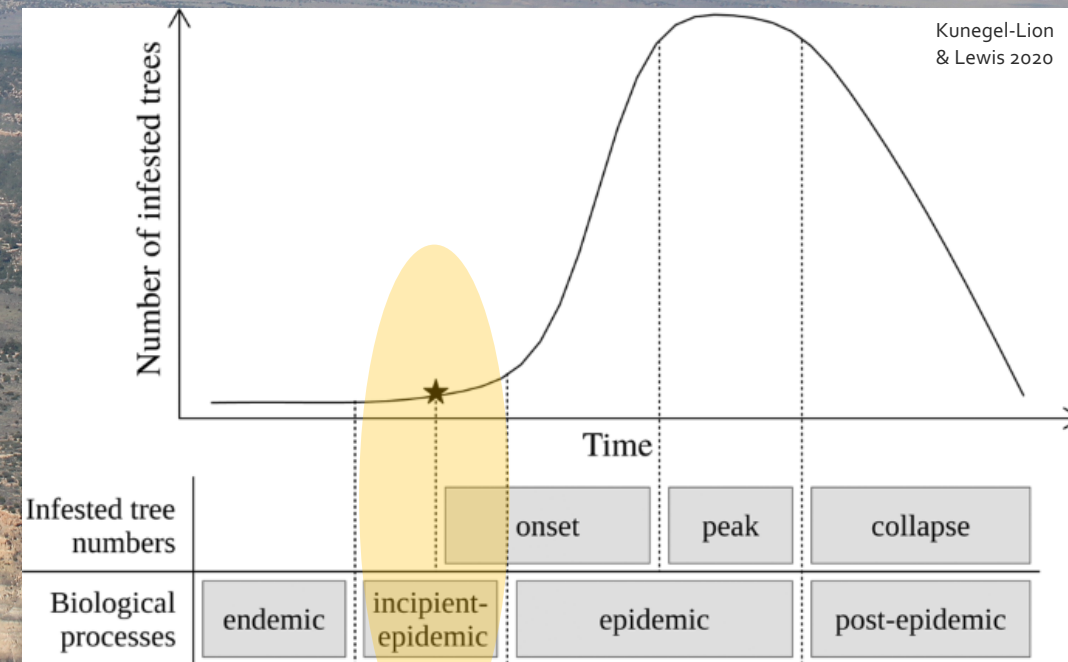
- Very few beetles

INTERMEDIATE (aka incipient-epidemic)

- A few infestation spots- most species rely on stressed, unhealthy, or damaged trees during this phase

OUTBREAK (aka epidemic)

- Massive population build-up, many trees damaged



MAJOR BARK BEETLE GENERA



Dendroctonus

Species in the genus can be identified by the host species they attack and egg gallery patterns

- ‘Tree killers’
- Attack and infest ‘healthy’ conifers
- Most economically and ecologically significant species affecting forest ecosystems
- Death of the host is often a requirement for successful brood production
- The female is the colonizing sex in the majority of *Dendroctonus* species
- To overcome the defenses of healthy, vigorous hosts, many beetles must attack within a short time (1–3 days)

Ips

Species can also be identified by the host species attacked and gallery patterns

- ‘Engraver beetles’
- Attack and infest weakened, dying, or recently felled conifers/fresh logging debris
- The male is the colonizing sex in *Ips* species
- Population may build up in response to natural and man-made events
 - Drought
 - Wind storms
 - Wildfire
 - Thinning operations

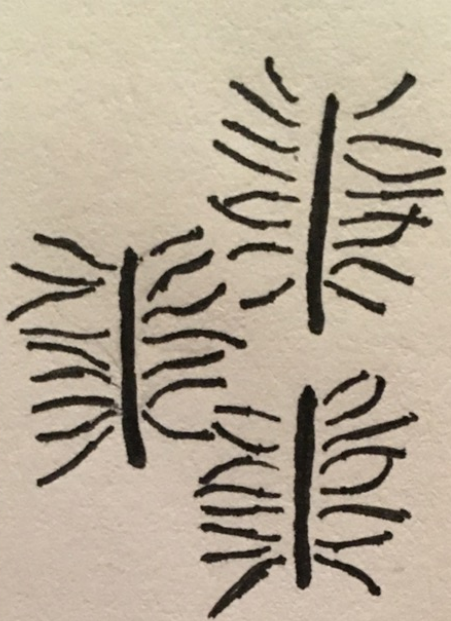
MAJOR BARK BEETLE GENERA



Dendroctonus

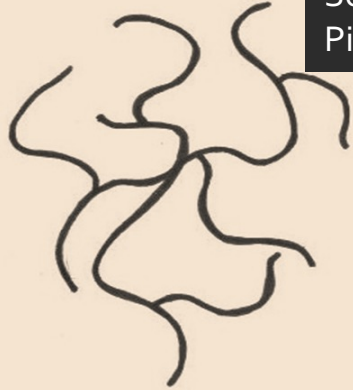
Various shapes of galleries (do not score sapwood)

Spruce Beetle



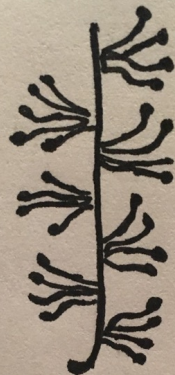
Drawing: Dr. Tom Coleman, USFS

Southwestern Pine Beetle



Drawing: Dr. Tom Coleman, USFS

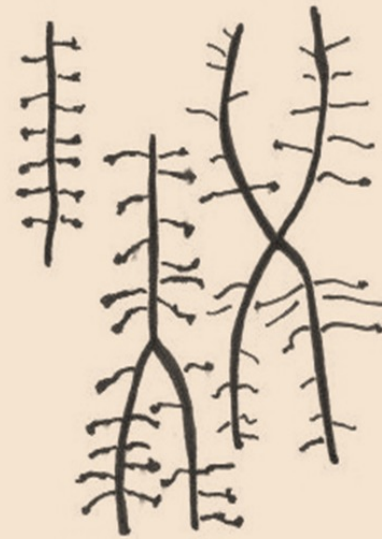
Douglas-fir Beetle



Drawing: Dr. Tom Coleman, USFS

Ips

Species Y, X, or I-shaped galleries (scores sapwood)



Drawing: Dr. Tom Coleman, USFS



Image: USFS

HOW DO TREES DEFEND THEMSELVES



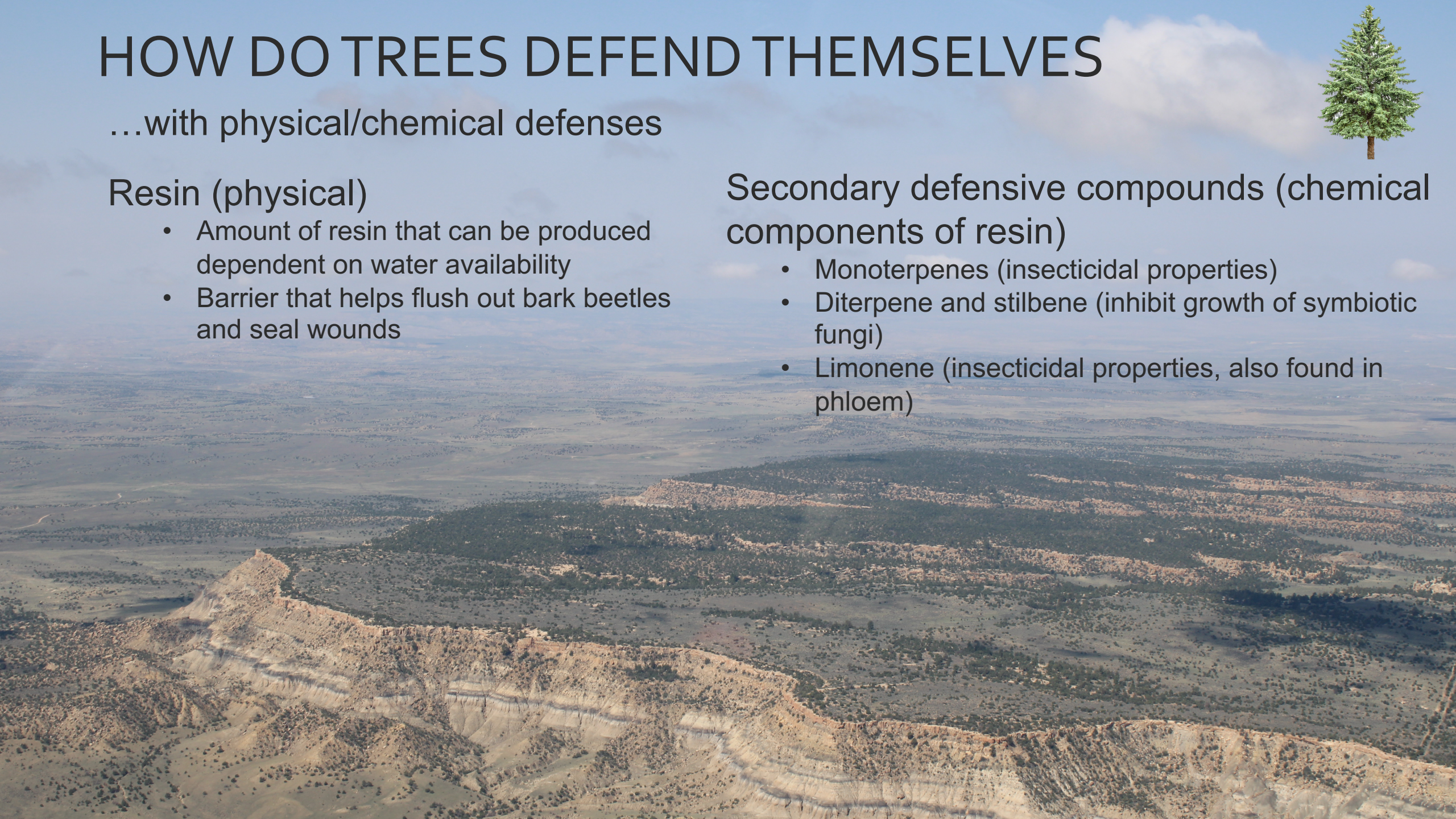
...with physical/chemical defenses

Resin (physical)

- Amount of resin that can be produced dependent on water availability
- Barrier that helps flush out bark beetles and seal wounds

Secondary defensive compounds (chemical components of resin)

- Monoterpenes (insecticidal properties)
- Diterpene and stilbene (inhibit growth of symbiotic fungi)
- Limonene (insecticidal properties, also found in phloem)



HOW CAN I PROTECT TREES AGAINST DROUGHT, HEAT, AND BARK BEETLES?



WHAT YOU CAN DO TO HELP PROTECT TREES (PIED/PIPO)

- **Properly** water overnight in times of drought
 - Water once/month if no precipitation occurs during that month (soaker hose or similar slow drip device)
 - High value trees
 - Water at ideal watering zone
 - Water 'berms' can be detrimental (mulch instead)
 - May need to move drip irrigation systems to ideal watering zone
 - Can overwater pinyon and juniper
- Insecticide sprays applied to bark late winter/early spring
 - Carbaryl, permethrin, and others
 - Reapply every 1 to 2 years
 - Off-target effects to beneficial insects and other animals
- Systemic insecticides (efficacy questionable)
 - Emamectin benzoate (Tree-äge©, Boxer©)
 - Offers protection for 2 years
 - Minimal off-target effects
- Thin trees on property
 - More resources for remaining trees
 - Bark beetle pheromones dissipate quicker
 - Generally, trees go through 'shock' for few years following thinning

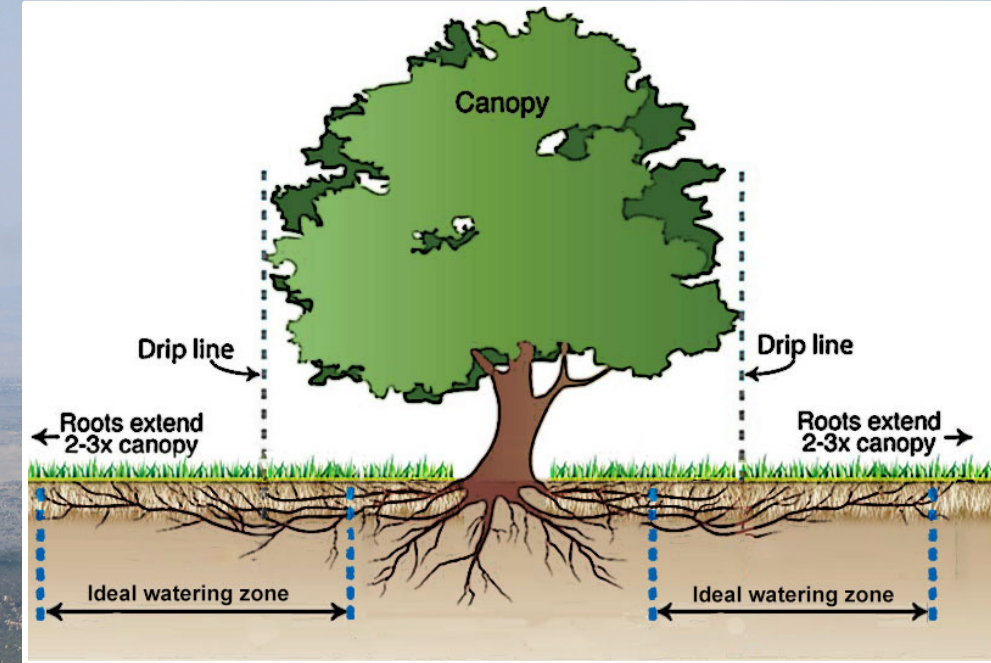


Image: Audubon Society

BEST TIME TO PRUNE OR FELL TREES?



CUTTING/THINNING/PRUNING RECOMMENDATIONS (PIED/PIPO)

- Cut, thin, prune during bark beetle inactive period
 - October-February
 - Strong suggestion, but not mandatory
- If thinned during active period, don't leave large diameter material on ground longer than 30 days
- Account for other forest health issues or site features within stand
- Monitor tree health post-thinning and reach-out to forestry/arborist professionals if trees start fading/dying



Ips-attacked felled pinyon

SLASH MGMT RECOMMENDATIONS

Chipping

- Initially releases very high levels of monoterpenes, but decline sharply over time²
- One study found a 3-fold increase in attacked trees in chipped plots v lop/scatter²
- Raking chips away from tree does not affect attack rates²
- No material left for bark beetles to colonize
- October to January only or chip into trailer and remove each day

Lop/scatter

- Monoterpene release is slow and steady
- Some material left on-site may be colonized
- May be safer than chipping or mastication during bb-active period

Mastication

- Monoterpene release somewhere between chipping and lop/scatter
- Some material left on-site may be colonized

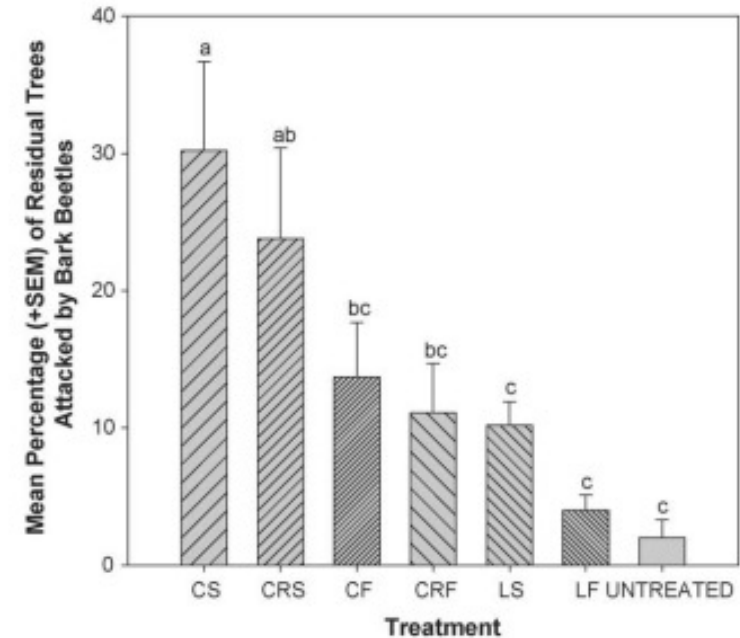


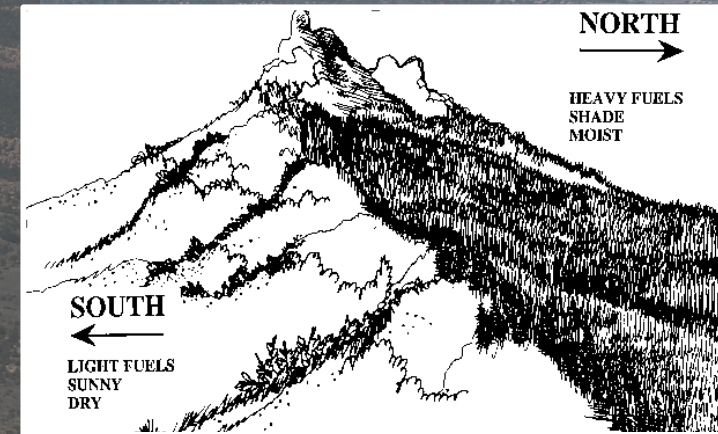
Fig. 2. Mean percentage (+S.E.M.) of residual trees attacked by bark beetles following hazardous fuel reduction treatments in Arizona and California, 2003–2004. Treatments were applied in late spring (S) and late summer (F) and included: (C) thinned biomass chipped and randomly dispersed within each plot, (CR) thinned biomass chipped, randomly dispersed, and raked 2 m from the root collar of residual trees, (L) thinned biomass lopped-and-scattered within each plot, and (Untreated) control. Means followed by the same letter are not statistically different ($P > 0.05$; Tukey's HSD).

SITE FEATURES THAT MAY INFLUENCE BARK BEETLE ACTIVITY

- Dwarf mistletoe
 - Tree mortality 3 to 4x higher than in uninfected areas
 - Bark beetles frequently attack heavily infected trees, especially during drought
 - Dwarf mistletoe on pinyon and ponderosa
- Aspect
- Elevation and Latitude
- Microclimate/microtopography

Check forest health web map for bark beetle activity in your area

- Limited surveys on S&P lands



WHAT YOU SHOULD DO WITH BARK BEETLE-INFESTED TREES

1. Cut and remove the tree(s) from the property promptly
 - Within 30 days but the sooner the better
 - 'Best choice'
 - Take to transfer station or somewhere without same species of tree
2. Fell tree and immediately cut into 1-2' sections
 - Remove as much bark as possible
 - Lay in single layer in sun away from healthy trees
3. Fell tree and immediately split into firewood
 - Stack away from healthy trees of same species
4. Does covering bark beetle-infested wood with plastic work?
 - Solarization
 - Issues



QUESTIONS?



Bark beetle-caused Engelmann spruce mortality (grey trees), Pecos Wilderness, SFNF



Common Tree Pests in New Mexico 2

John Formby

RM-23-041

REFERENCES

- ¹ <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1034&context=usgsstaffpub>
- ² <https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1021&context=barkbeetles>

