ECOLOGY: EFFECTS OF FIRE ON VEGETATION

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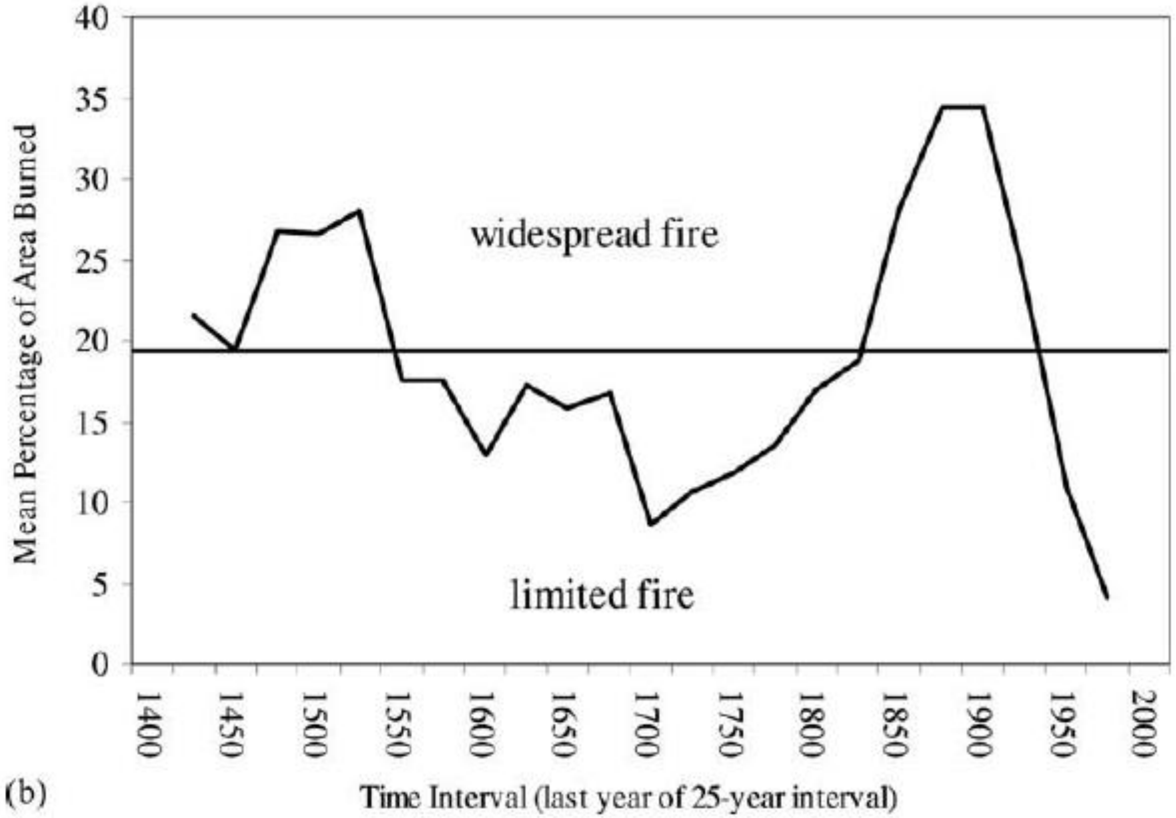
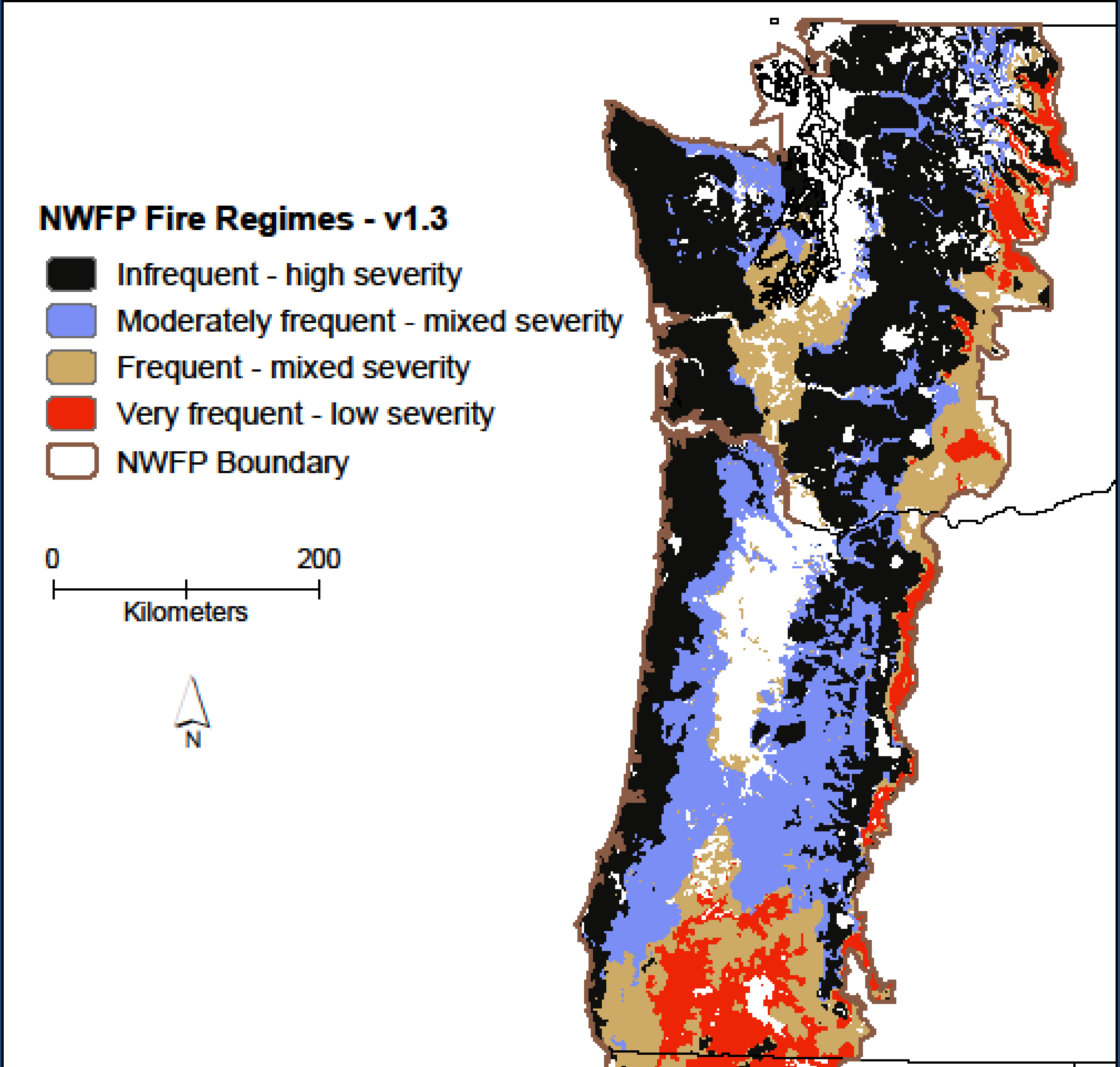
Synchronous fire regimes in the Pacific Northwest in recent centuries
(10 sites west of Cascade crest, OR & WA)

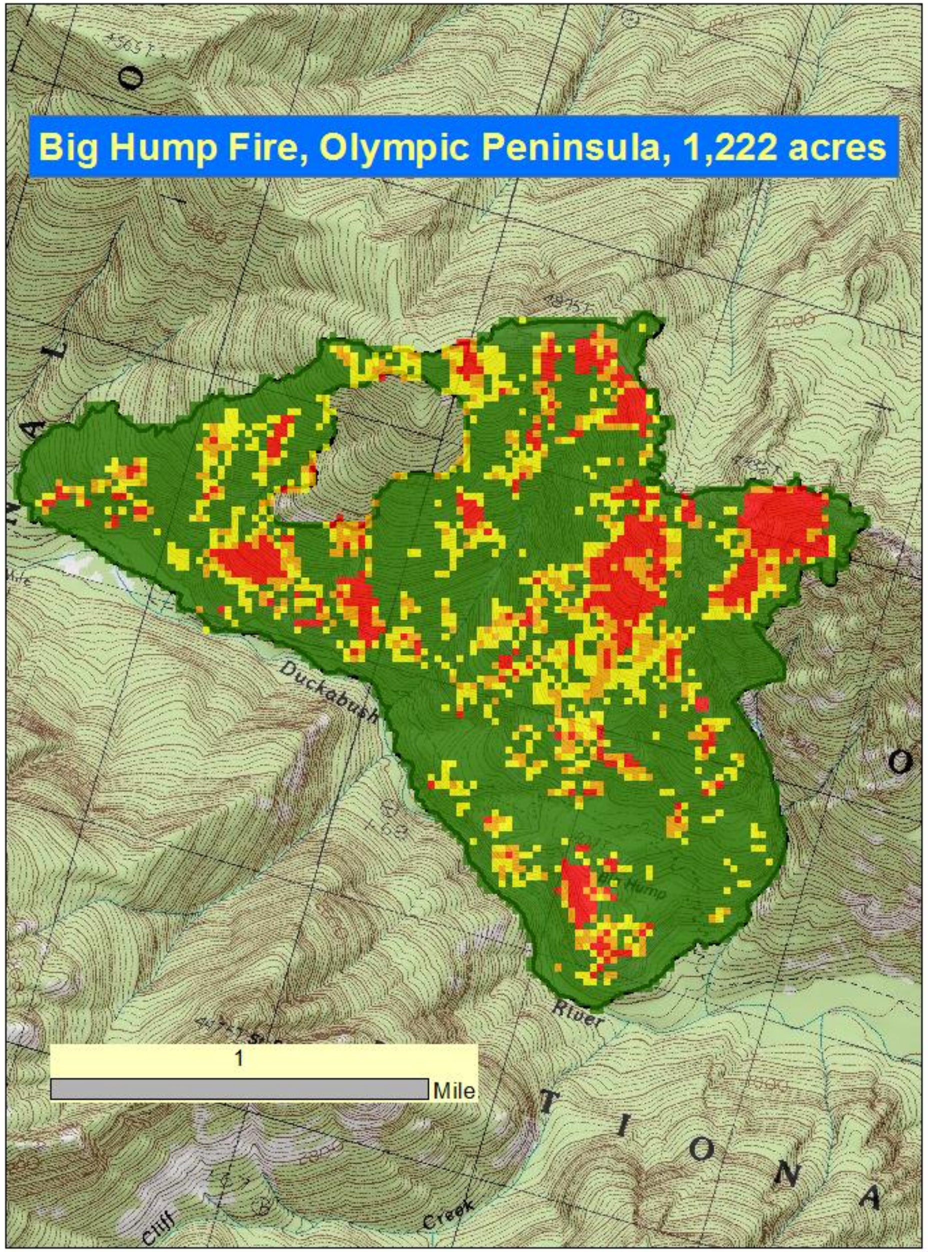


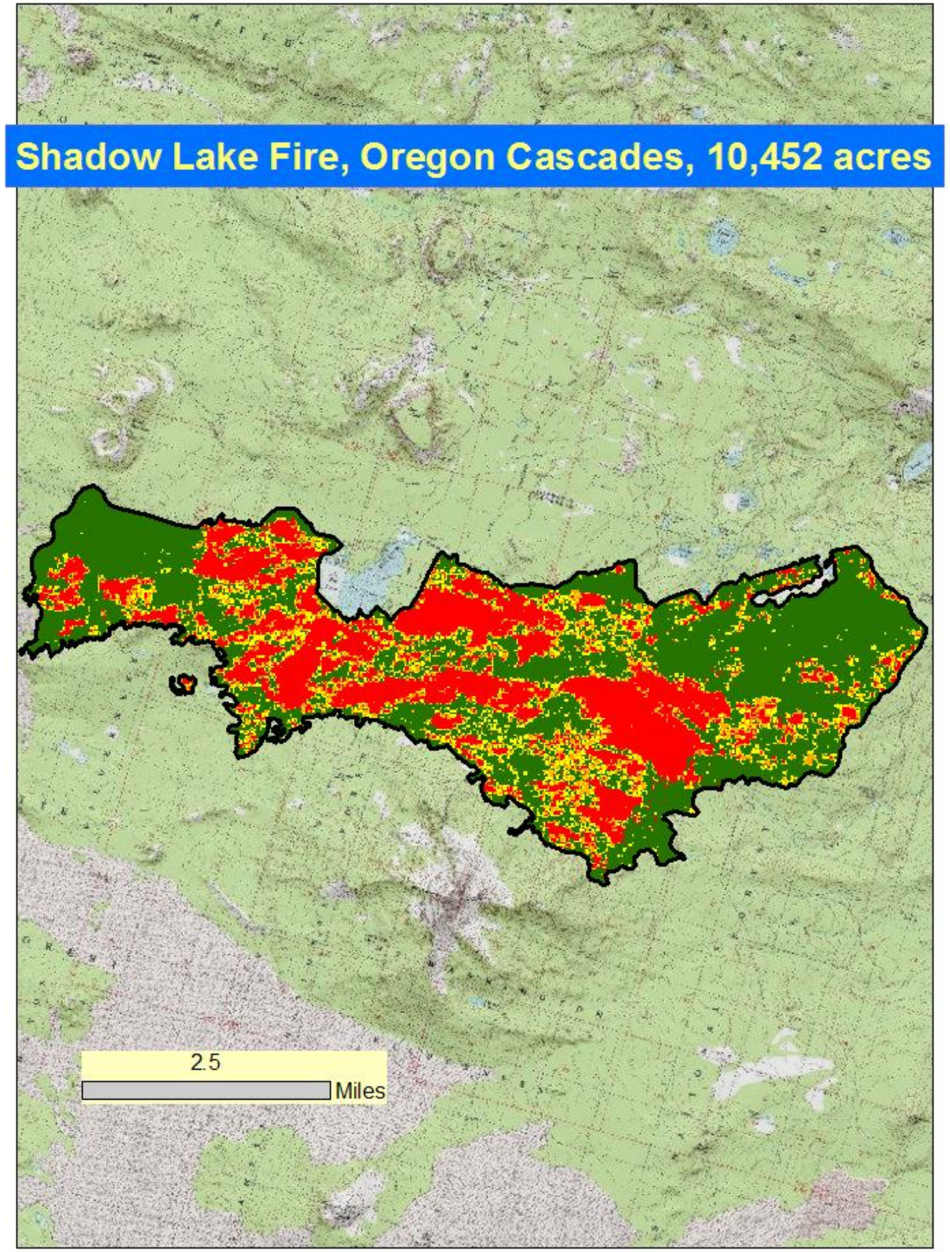
Source: Weisberg & Swanson, 2003, For. Ecol. Manag. 172:17-28



Spies et al., in press. Northwest Forest Plan Synthesis

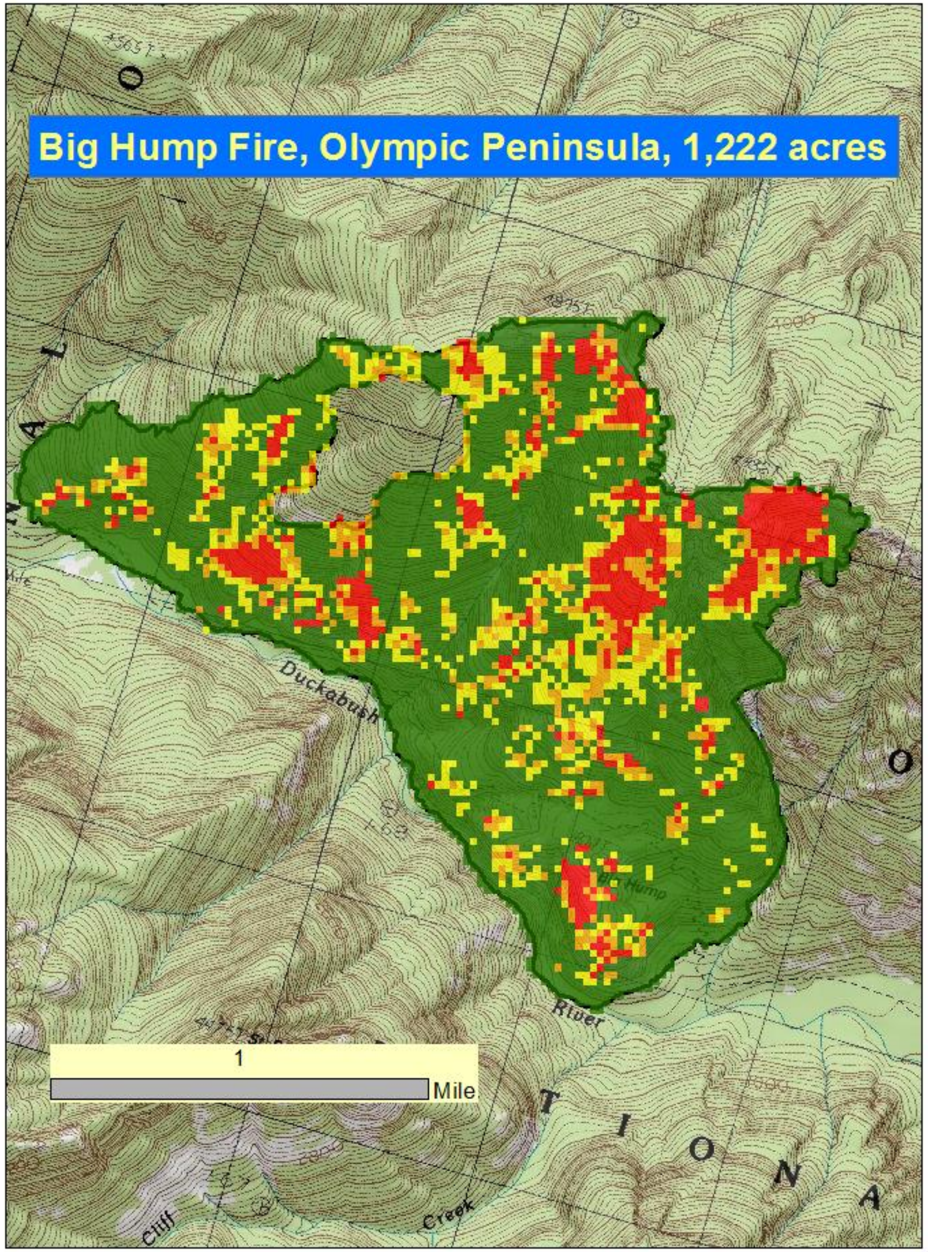
Two fires from 2011





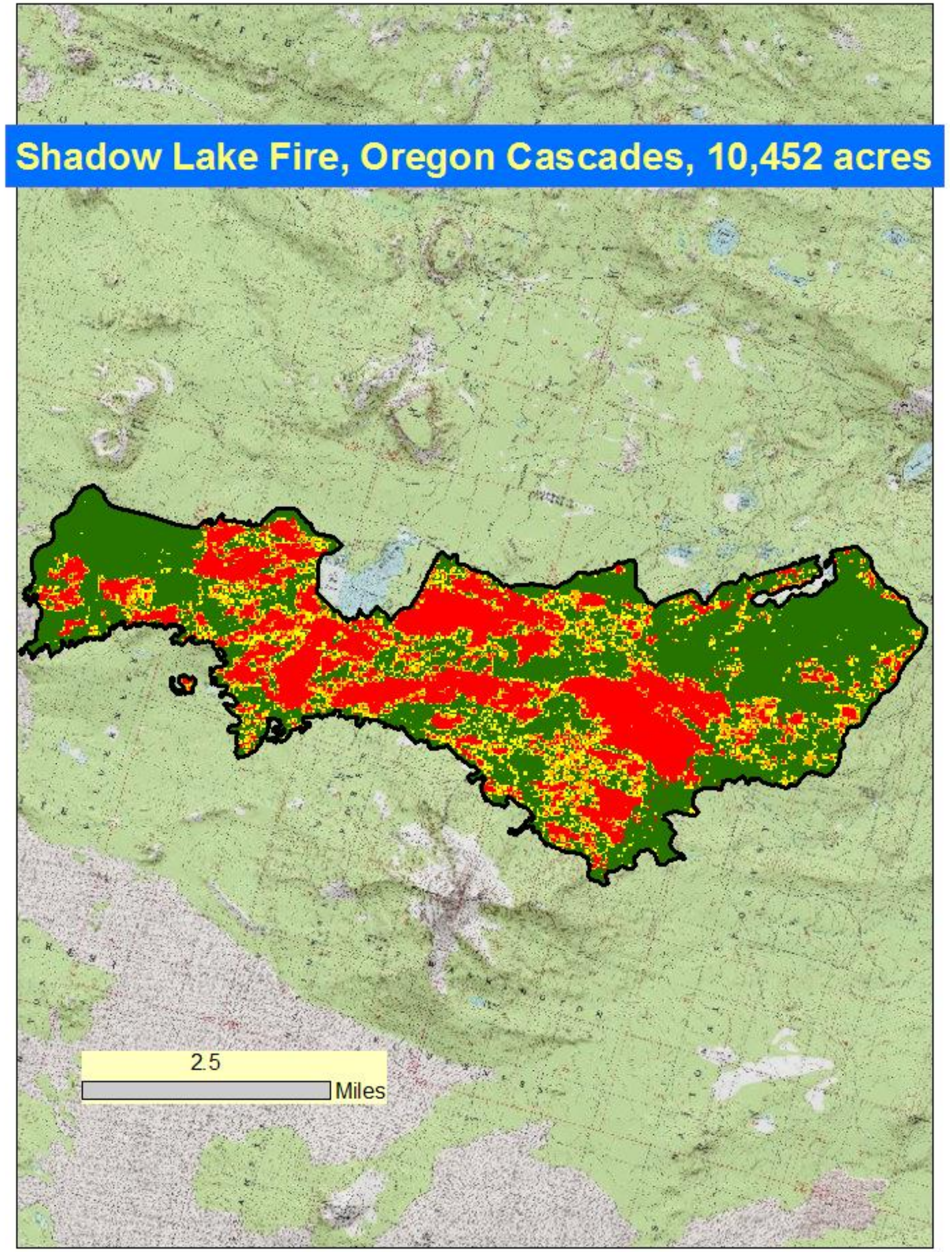
Basal Area Loss, RAVG

- 0% - <25%
- 25% - < 50%
- 50% - < 75%
- 75% - 100%



Two fires from 2011

Variability in severity due to fuels, weather, topography



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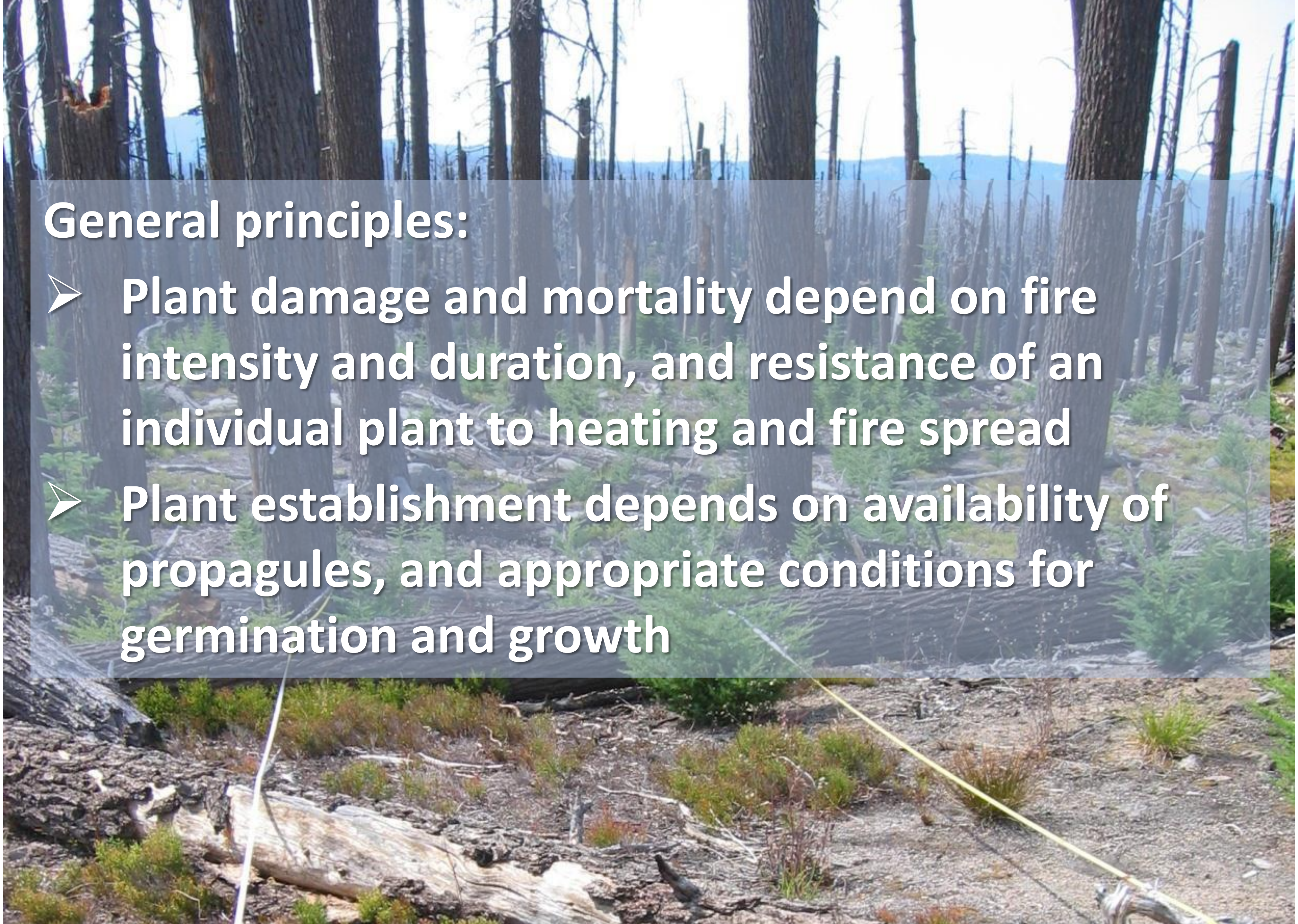
Effects on populations of organisms:

1) cumulative individual effects
2) propagule dispersal
3) propagule establishment

Effects on individual organisms:

1) damage
2) top-kill and resprouting
3) mortality



General principles:

- Plant damage and mortality depend on fire intensity and duration, and resistance of an individual plant to heating and fire spread
- Plant establishment depends on availability of propagules, and appropriate conditions for germination and growth

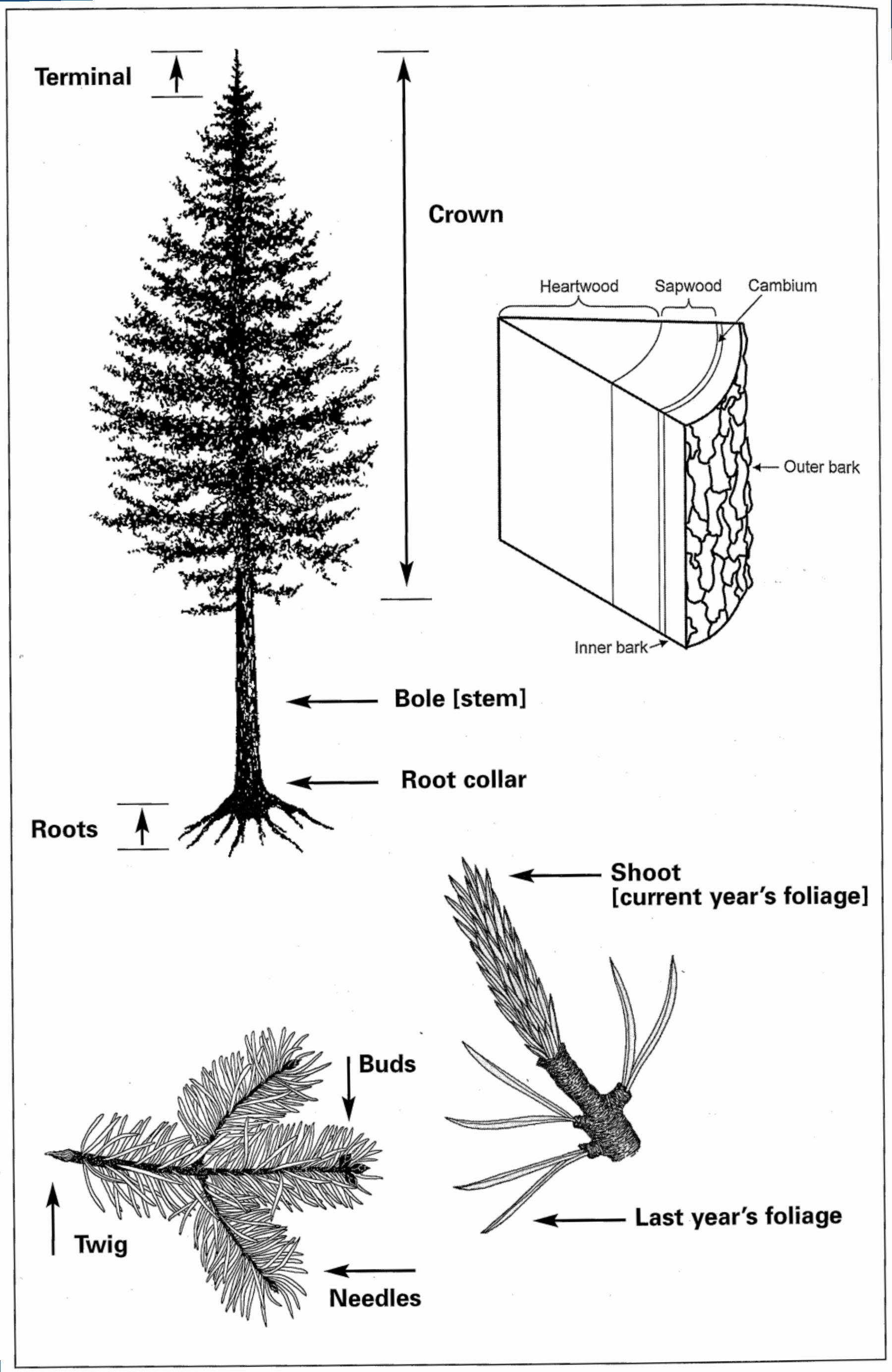


Figure 1b–Parts of a tree.

Douglas-fir: effects on individuals

- Mature trees have thick bark
- Often grows to great height (250 feet)
- Sheds lower branches in closed-canopy stands
- Cambium can be killed by long-duration heating (smoldering logs, deep duff)
- Does not sprout after top-kill
- Post-fire mortality three years post predicted by crown scorch, cambium kill, presence of DF beetle (Ganio & Progar 2017)

Douglas-fir: effects on populations

- Seed longevity one to two years
- Many years without substantial cone crops
- Wind is primary agent of seed dispersal; most seeds fall with 330 feet of source tree
- Germination and seedling growth favored by mineral soil and high sunlight

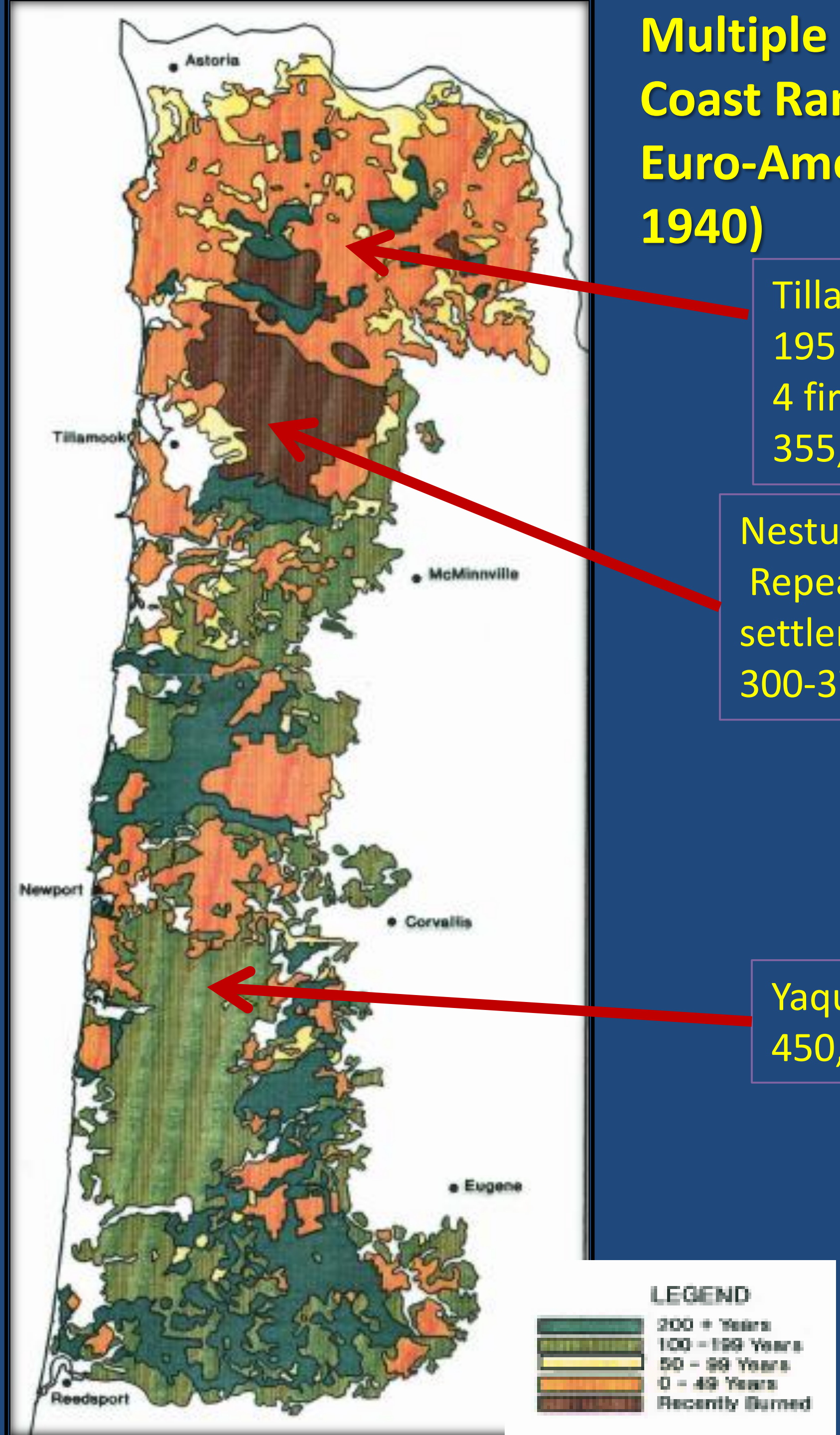
Western hemlock: effects on individuals

- Trees have thin bark
- Often grows to moderate height (200 ft)
- Usually maintains lower branches, leading to elongated crown
- Has shallow roots that are susceptible to ground fire
- Does not sprout after top-kill
- Post-fire mortality three years post predicted by cambium kill, presence of bark beetles, dbh, crown scorch (Grayson et al. 2017)

Western hemlock: effects on populations

- Seeds viable until subsequent growing season
- Seeds produced every year; heavy cone crops every three or four years (trees ≥ 25 yrs old)
- In open, windy conditions, most seeds fall within 2000 feet of source
- Scarce in some portions of Oregon Coast Range due to removal of seed source by fires since ~1850.

Multiple extensive fires in Oregon Coast Range in century following Euro-American settlement (~1850 to 1940)

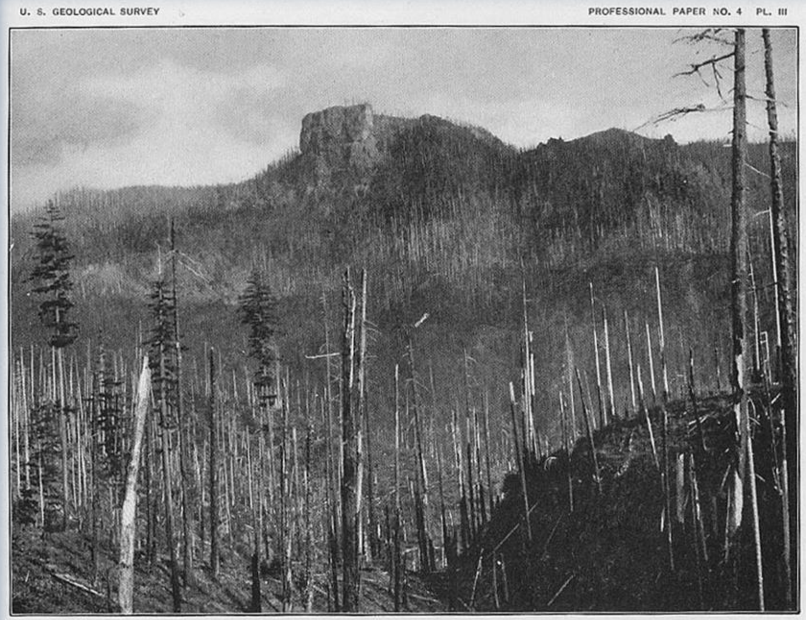


Tillamook: 1933-1951;
4 fires
355,000 total acres

Nestucca: 1845/6/7
Repeated reburn by settlers;
300-375,000 total acres

Yaquina 1849;
450,000 total acres

Teensma et. al 1991



A. THE GREAT NESTUCCA BURN.

B. THE GREAT YAQUINA BURN.

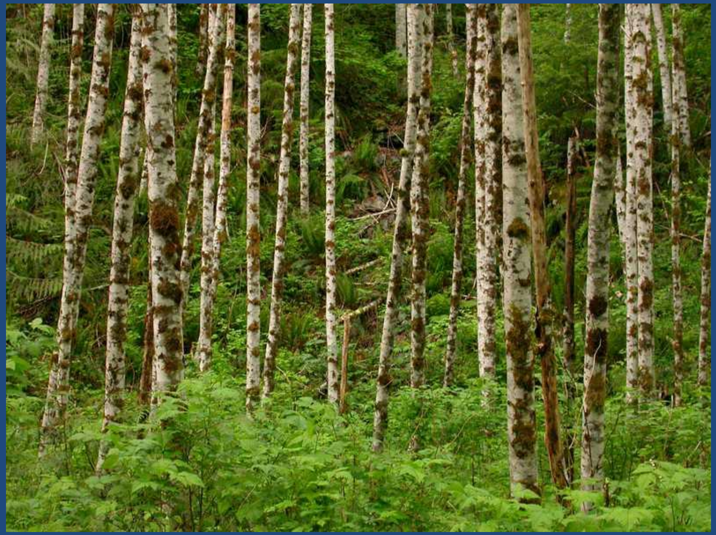
Tanoak: effects on individuals

- Mature trees have bark of medium thickness
- Shrub or medium-sized tree (to 80’ tall)
- Variety of growth forms, but generally ignites easily due to flammable leaves and location in subcanopy
- Small stems usually succumb to low-severity fire; large trees usually survive moderate-severity fire
- Sprouts abundantly from belowground burls

Tanoak: effects on populations

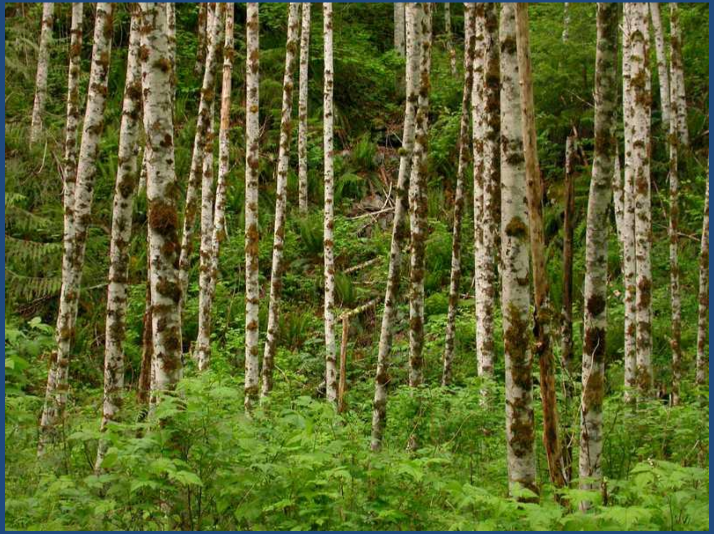
- Acorns can survive as transient seedbank with shallow burial
- Acorns produced most years; heavy crops typically every other year
- Most acorns fall directly beneath parent tree; some dispersal and caching by jays and squirrels
- Seedlings thrive under intact forest; acorn predation limits establishment in disturbed sites.

Red alder: effects on individuals



- Trees have thin bark
- Medium-sized tree (to 130 feet tall)
- Alder stands rarely burn due to moist site conditions and lack of combustible debris
- Young trees sprout from stump after cutting; response to fire not documented

Red alder: effects on populations



- Seed bank probably not an important aspect of regeneration
- Believed to have prolific and consistent seed production (long-term studies lacking)
- Very small seeds very widely dispersed by wind
- Seeds germinate and grow well on moist mineral soil in full sunlight

A few more tree species

	Bark	Crown architecture	Roots	Sprouts	Seed produc-tion	Seed dispersal
Sitka spruce	Thin	Loses lower limbs in dense stands	Shallow	Evidently not	Periodic	Up to ½ mile by wind
ponderosa pine	Thick	Open, clear lower bole	Deep and shallow	No	Periodic	Up to 100 feet by wind; also birds
Pacific silver fir	Thin	Can lose lower limbs in dense stands	Shallow	No	Periodic	Seeds relatively heavy
mountain hemlock	Thick	Retains all branches (except dense stands)	Shallow	Evidently not	Periodic	Up to 375 feet by wind

Some native understory plants with strongly positive responses to fire

	Sprouting	Recruitment from seeds	Seed prod-uction	Seed dispersal	Seed bank?
Snowbrush	Vigorous	•Yes •Heat-induced	Abundant	Limited	Up to 200 years
Salmon-berry	Vigorous	•Yes •Favored by mineral soil	Abundant	Birds and mammals	Long-lived
Vine maple	Abundant, except with high severity	Rarely observed	n/a	n/a	n/a

Some native understory plants with less positive responses to fire

	Sprouting	Recruit-ment from seeds	Seed prod-uction	Seed dispersal	Seed bank?
Salal	Abundant, except with high severity	Limited	Abundant except under dense shade	Birds and mammals	Probably not important
Red huckle-berry	Abundant, except with high severity	Limited	Abundant	Birds and mammals	Probably not important
Pacific rhodo-dendron	Slowly, after low–severity fires	Occurs to some extent	Probably abundant	Not docu-mented	No--seed longevity two years

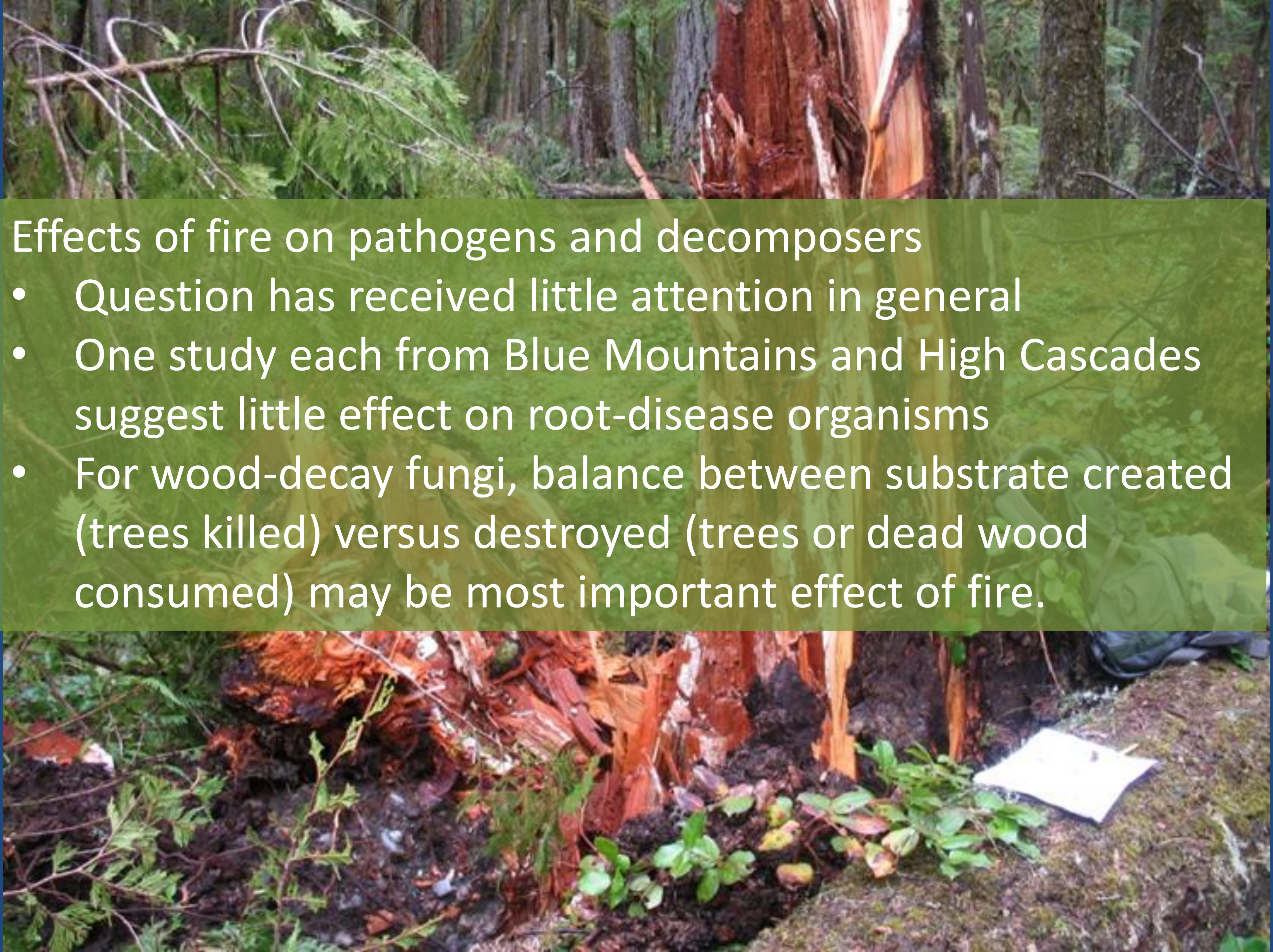
A few nonnative, invasive plants

	Sprouting	Recruit-ment from seeds	Seed prod-uction	Seed dispersal	Seed bank?
Scotch broom	Variable, limited by high-severity fire	•Abundant •Stimulated by fire	Abundant but variable	Ants, vehicles, flowing water	Yes--seed survives for decades
Canada thistle	Yes--withstands high-severity fire	Common	Variable	Wind probably most important	Probably limited
False brome	Occurs	Occurs	Abundant	Mammals, vehicles	Yes (at least in native range)

Fungi and forests: mycorrhizae, pathogens and decomposers, food sources, …

Effects of fire on mycorrhizal fungi

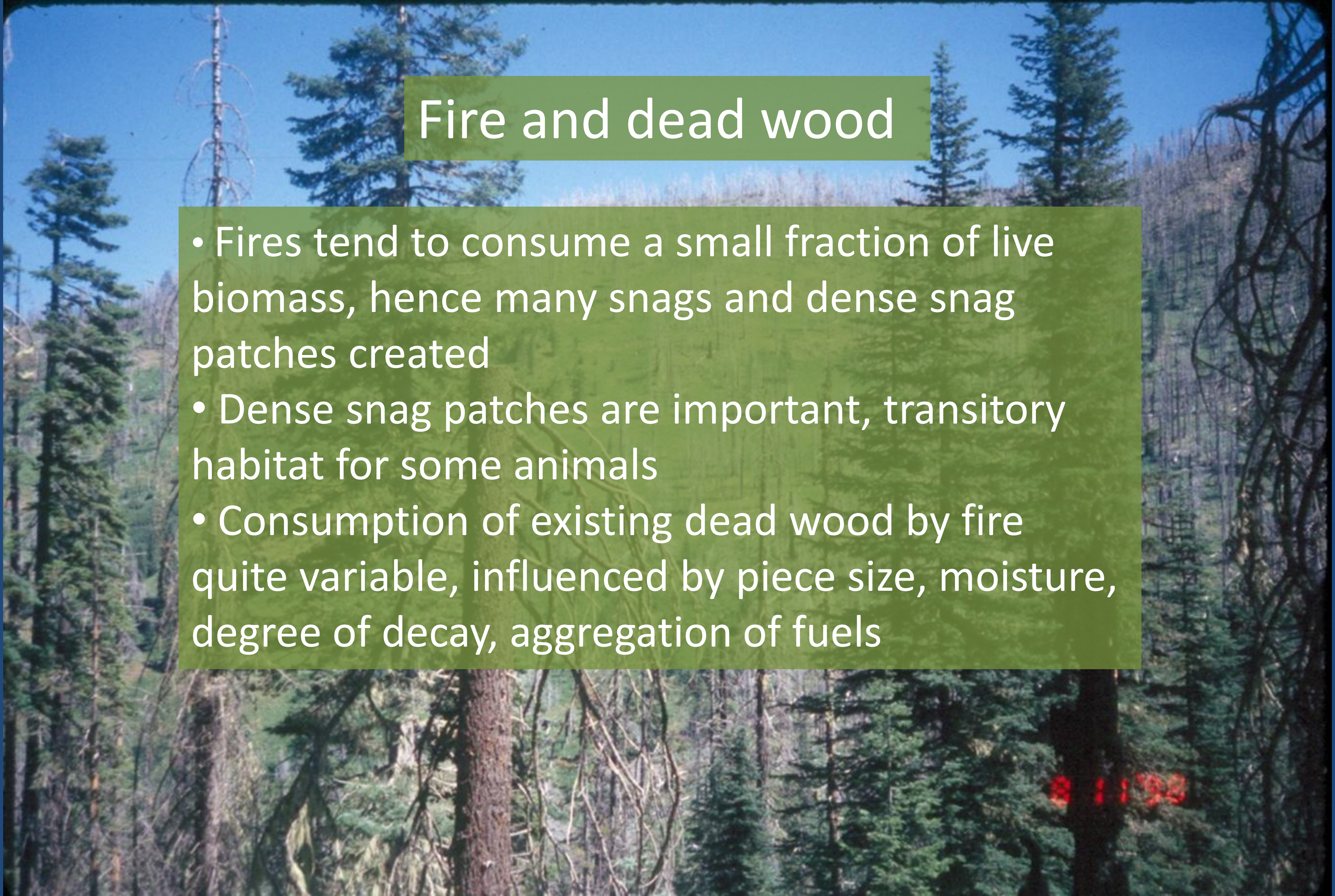
- Evidently not studied for westside
- Recent work by Jane Smith and colleagues, PNW Research Station, from east slope of Cascades (B&B Fire and Pringle Falls Experimental Forest)
  - ➢ Though high-intensity fire can produce lethal temperatures in top soil layers, recovery may be rapid
  - ➢ Proximity to unburned or minimally-burned patches probably facilitates return of mycorrhizal species



Effects of fire on pathogens and decomposers

- Question has received little attention in general
- One study each from Blue Mountains and High Cascades suggest little effect on root-disease organisms
- For wood-decay fungi, balance between substrate created (trees killed) versus destroyed (trees or dead wood consumed) may be most important effect of fire.

Dead wood: integral component of forests representing habitat, food source, links in ecosystem processes, …



Fire and dead wood

- Fires tend to consume a small fraction of live biomass, hence many snags and dense snag patches created
- Dense snag patches are important, transitory habitat for some animals
- Consumption of existing dead wood by fire quite variable, influenced by piece size, moisture, degree of decay, aggregation of fuels

Some key points

- Fire intensity/severity variable in space and time
- Damage, top-kill, or death of individual plants depend on intensity and duration of heating
- Plant attributes such as bark thickness, height, rooting depth vary with species and size
- Population/landscape effects influenced by sprouting, seed production/dispersal/persistence
- Information sparse for important groups of fungi, though effects may be minimal
- Fire consumes but mostly creates dead wood

Information sources

1) Fire effects on plants

- Fire Ecology of Pacific Northwest Forests (J.K. Agee, 1993, Island Press)
- Fire Effects Information System (www.feis-crs.org/feis/)
- Silvics of North America (www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm)
- Wildland fire in ecosystems: effects of fire on flora (www.firescience.gov/projects/98-S-01/project/Flora.pdf)

Information sources

1) Fire effects on plants, continued

- Ganio, L.M., and R.A. Progar. 2017. Mortality predictions of fire-injured large Douglas-fir and ponderosa pine in Oregon and Washington, USA. Forest Ecology and Management 390:47–67.

- Grayson, L.M., R.A. Progar, S.M. Hood. 2017. Predicting post-fire tree mortality for 14 conifers in the Pacific Northwest, USA: Model evaluation, development, and thresholds. Forest Ecology and Management 399:213–226.

Information sources

2) Fire severity maps

- Rapid Assessment of Vegetation Condition after Wildfire (www.fs.fed.us/postfirevegcondition/index.shtml)
- Monitoring Trends in Burn Severity (MTBS) (www.mtbs.gov/index.html)
- Reilly, M.J., C.J. Dunn, G.W. Meigs, T.A. Spies, R.E. Kennedy, J.D. Bailey, and K. Briggs. 2017. Contemporary patterns of fire extent and severity in forests of the Pacific Northwest, USA (1985–2010). Ecosphere 8(3): e01695. 10.1002/ecs2.1695

Information sources

3) Current vegetation

- Gradient Nearest Neighbor Vegetation Structure maps
  (lemma.forestry.oregonstate.edu)