ECOLOGY: EFFECTS OF FIRE ON VEGETATION

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- General concepts
- 2017 fires in McKenzie watershed

Effects on individual organisms:

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

Effects on populations of organisms:

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

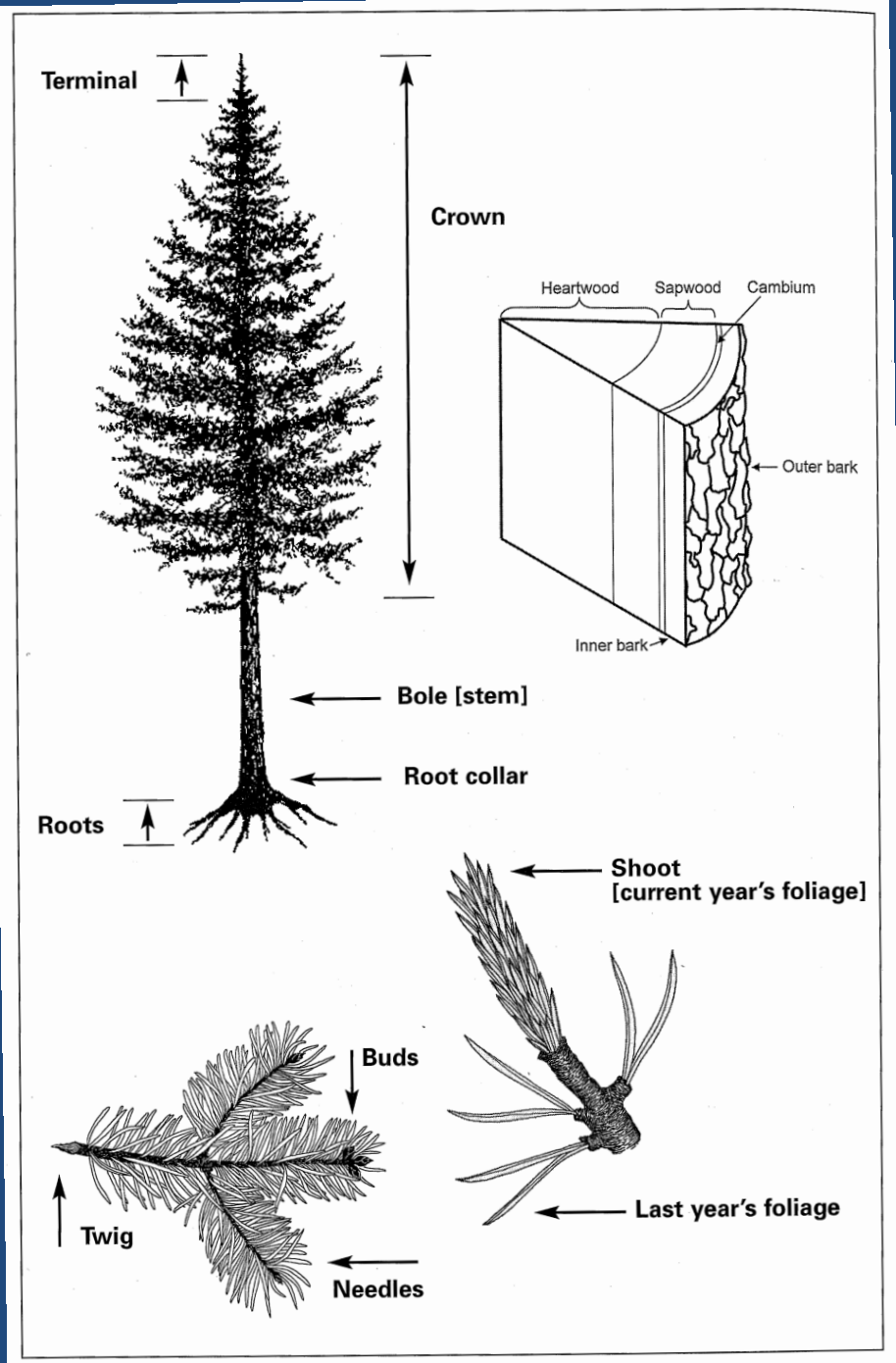
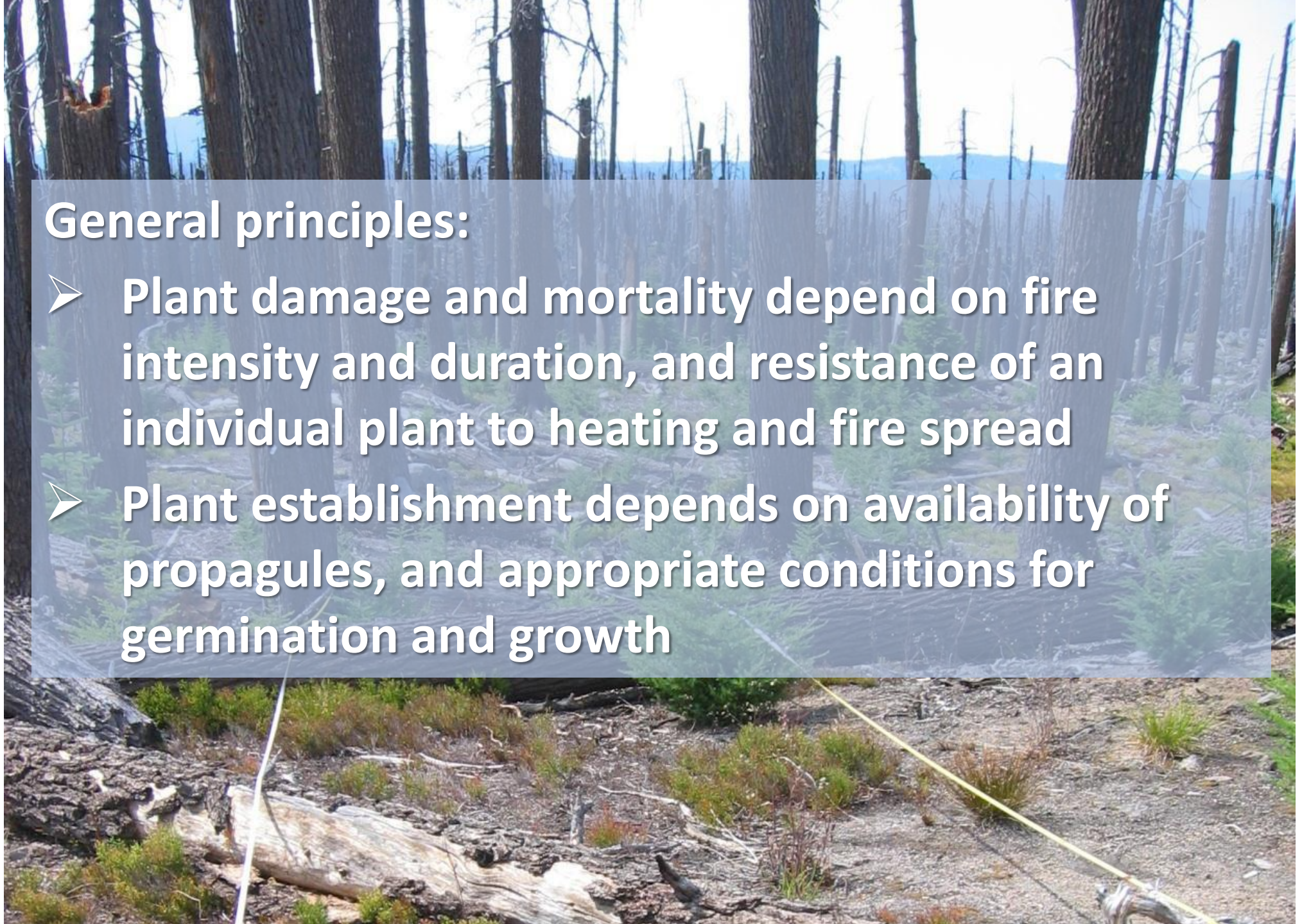


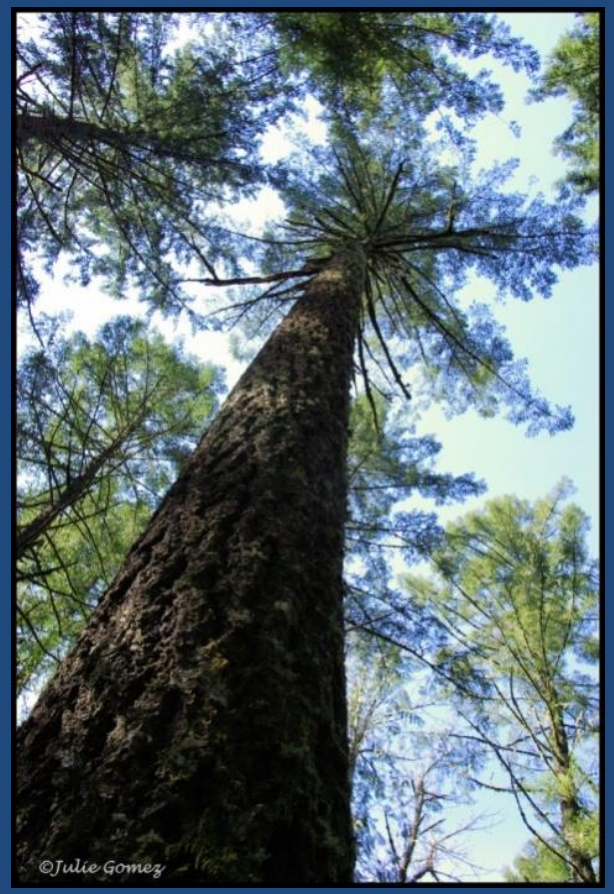
Figure 1b–Parts of a tree.



General principles:

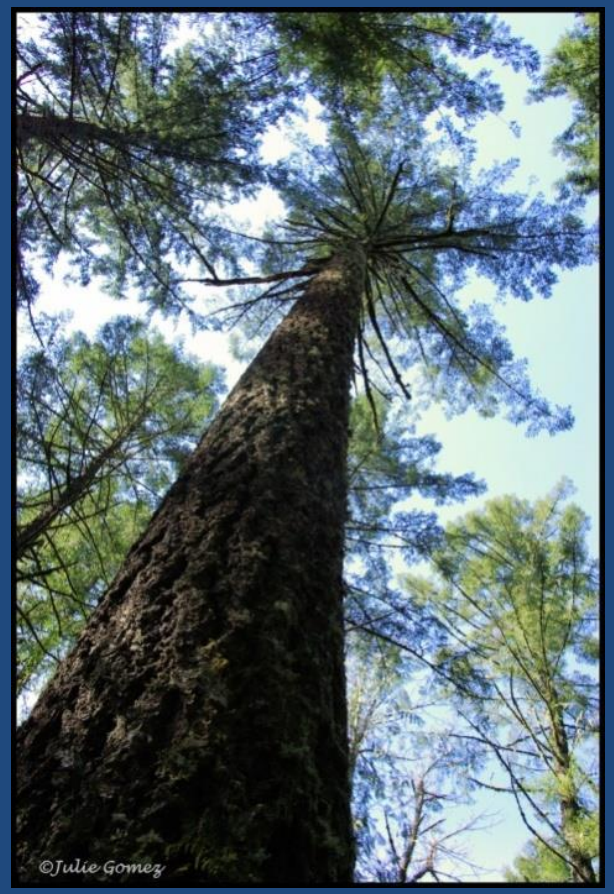
- Plant damage and mortality depend on fire intensity and duration, and resistance of an individual plant to heating and fire spread
- Plant establishment depends on availability of propagules, and appropriate conditions for germination and growth

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.

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

A few nonnative, invasive plants

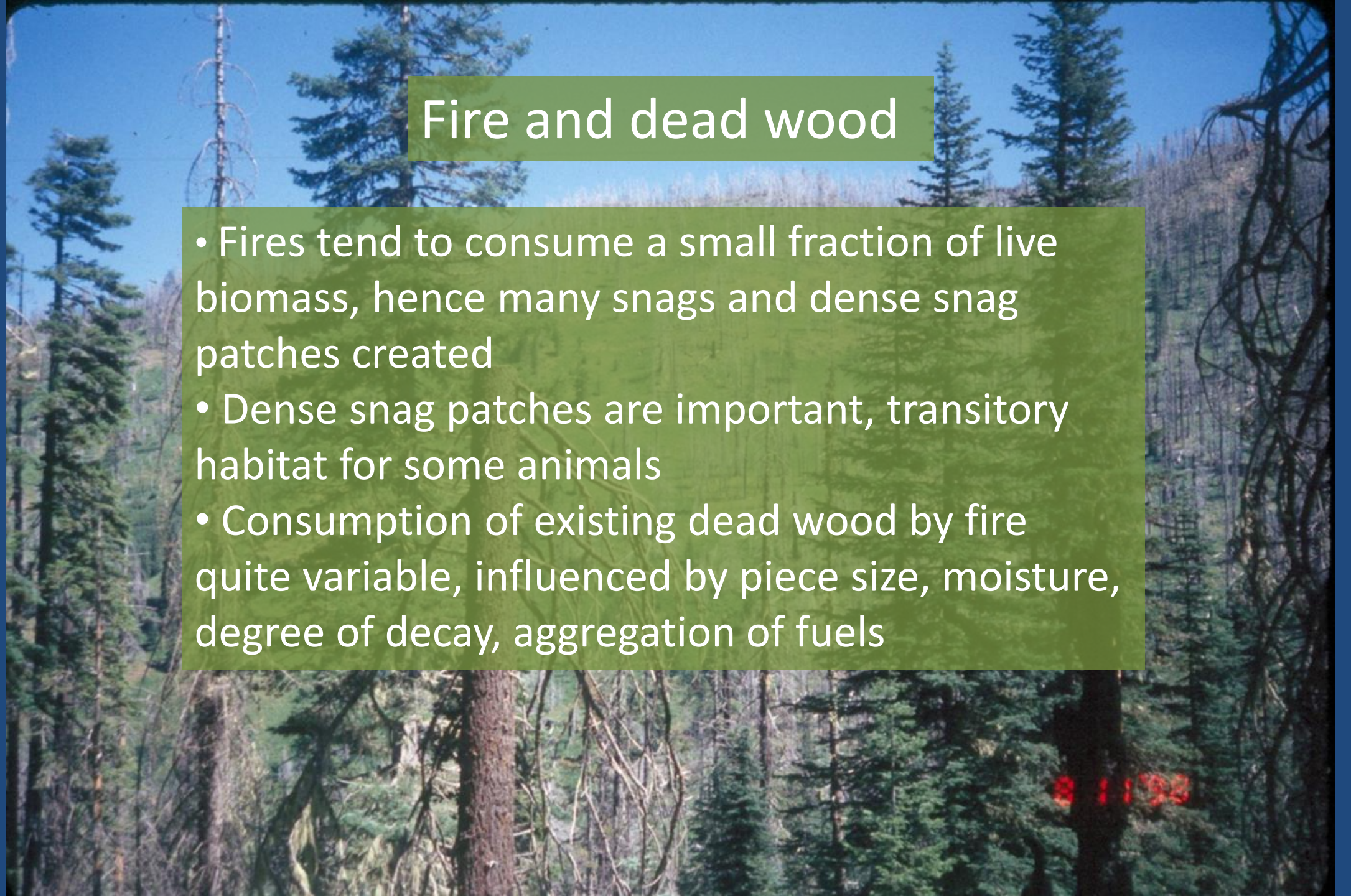
	Sprouting	Recruit-ment from seeds	Seed prod-uction	Seed dispersal	Seed bank?
Scotch broom	Variable, limited by high-severity fire	•Abundant •Stimulated by fire	Abundant but variable	Ants, vehicles, flowing water	Yes--seed survives for decades
Canada thistle	Yes--withstands high-severity fire	Common	Variable	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 (Blue Mountains, Sierra Nevada, Rockies, Scandinavia…)
- 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

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

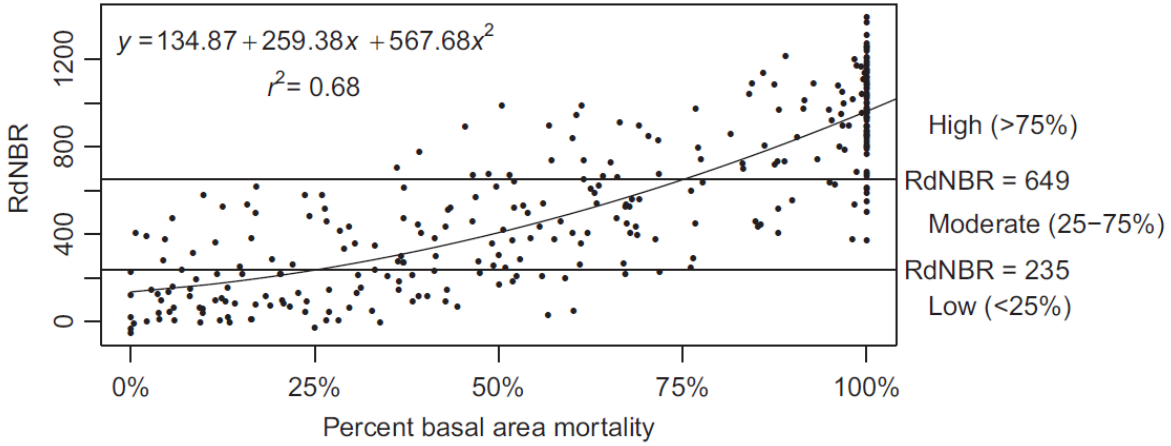


Fire and dead wood

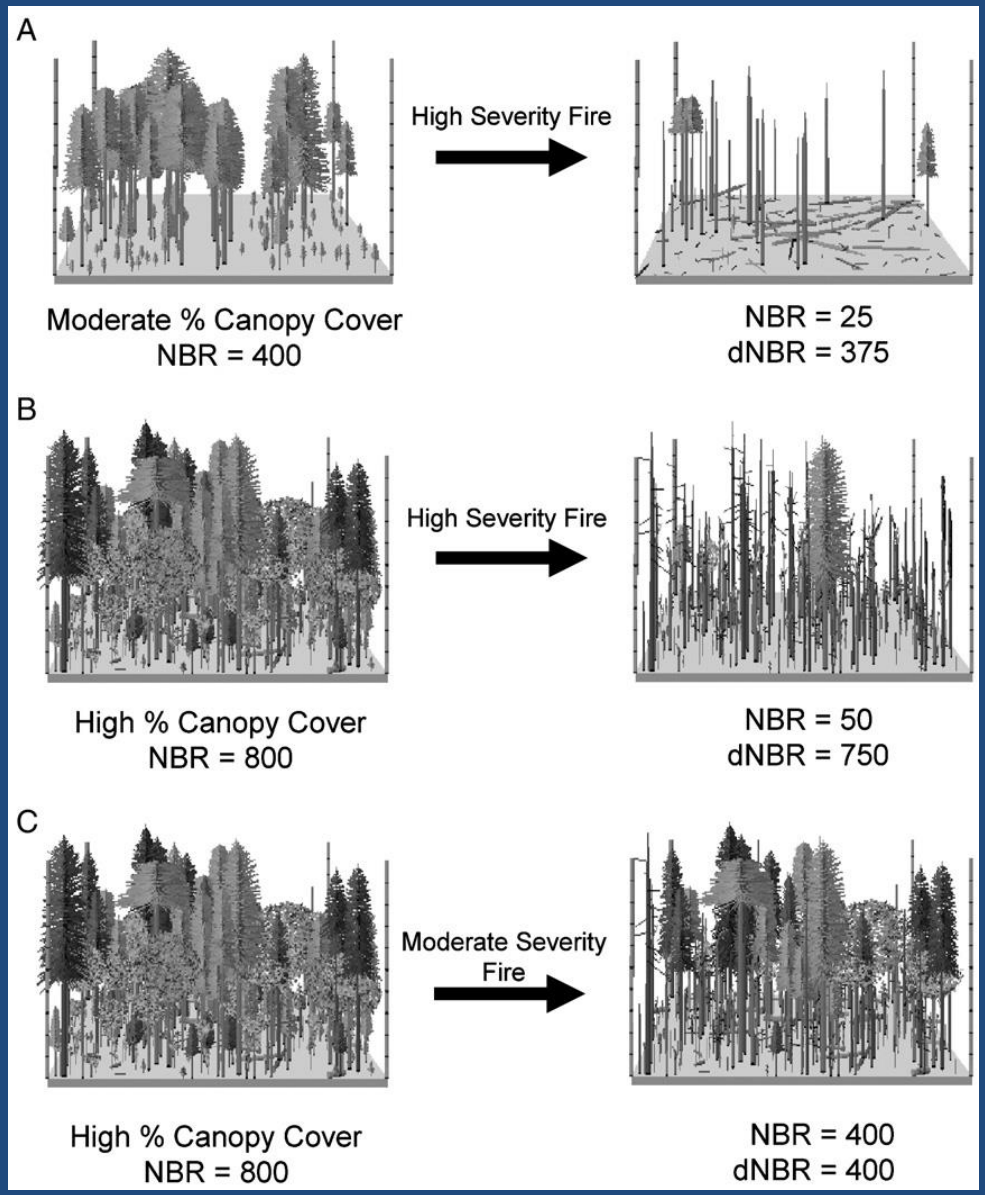
- Fires tend to consume a small fraction of live biomass, hence many snags and dense snag patches created
- Dense snag patches are important, transitory habitat for some animals
- Consumption of existing dead wood by fire quite variable, influenced by piece size, moisture, degree of decay, aggregation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

Fire severity from satellite remote sensing

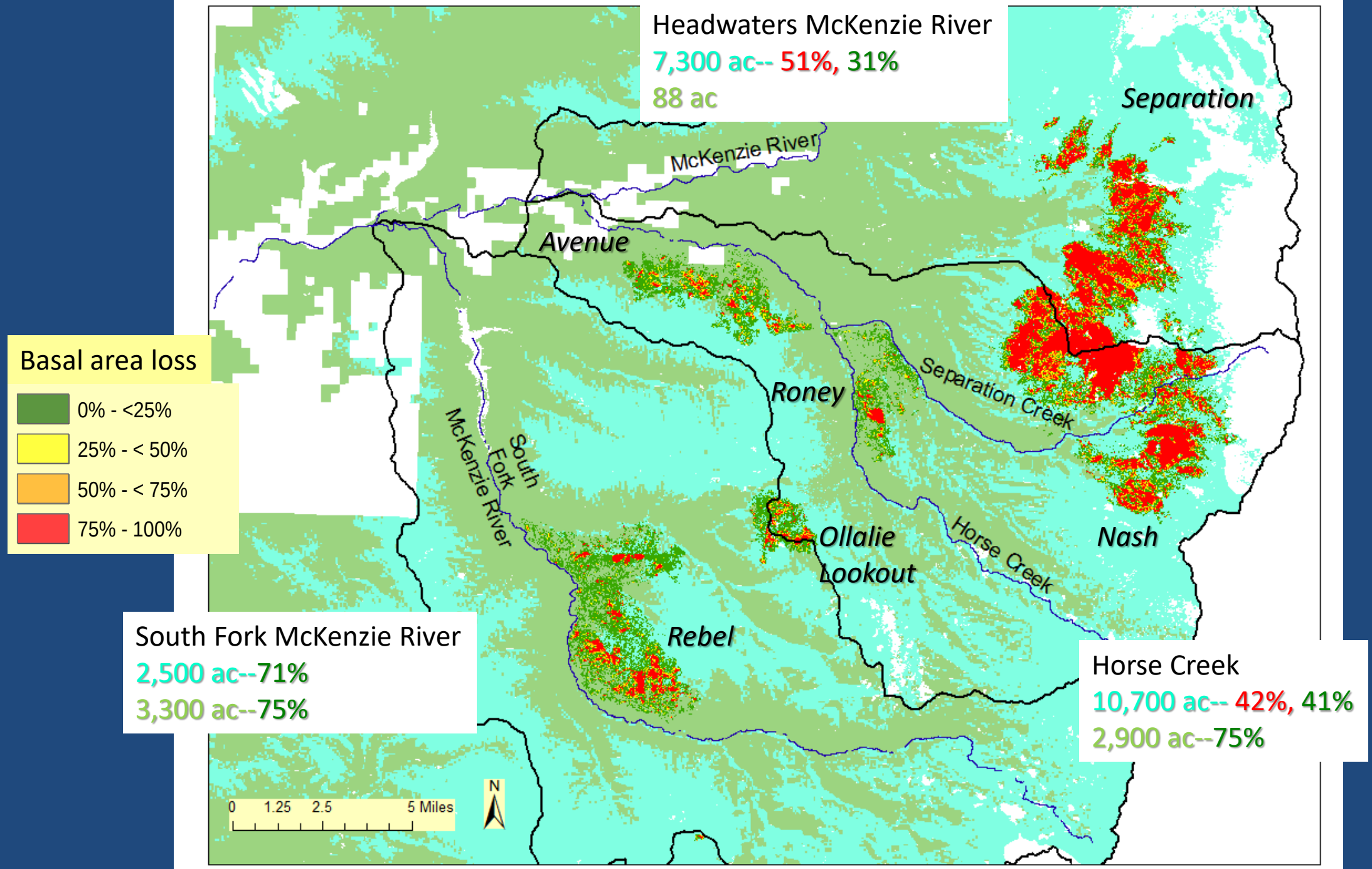
- Source is Landsat, or more recently Sentinel from European Space Agency
- Compares near-infrared (chlorophyll in live vegetation) and mid-infrared (water in soils and vegetation, lignose of dead vegetation, soil minerals)
- Generates “Normalized Burn Ratio”
- Difference between pre- and post-fire values can be associated with varying degrees of tree mortality



Reilly et al. 2017.



Miller, Jay D., & Thode, Andrea E. 2007. Quantifying burn severity in a heterogeneous landscape with a relative version of the delta Normalized Burn Ratio (dNBR). Remote Sensing of Environment 109:66-80.


Headwaters McKenzie River
7,300 ac-- 51%, 31%
88 ac
Separation
McKenzie River
Avenue
Roney
Separation Creek
South Fork McKenzie River
Ollalie Lookout
Horse Creek
Nash
Rebel
Basal area loss
0% - <25%
25% - < 50%
50% - < 75%
75% - 100%
South Fork McKenzie River
2,500 ac--71%
3,300 ac--75%
Horse Creek
10,700 ac-- 42%, 41%
2,900 ac--75%
0 1.25 2.5 5 Miles
N

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 effects on fungi

- Interagency Special Status / Sensitive Species Program (ISSSSP) (https://www.fs.fed.us/r6/sfpnw/issssp/species-index/flora-fungi.shtml)

Information sources

3) 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

4) Current vegetation

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