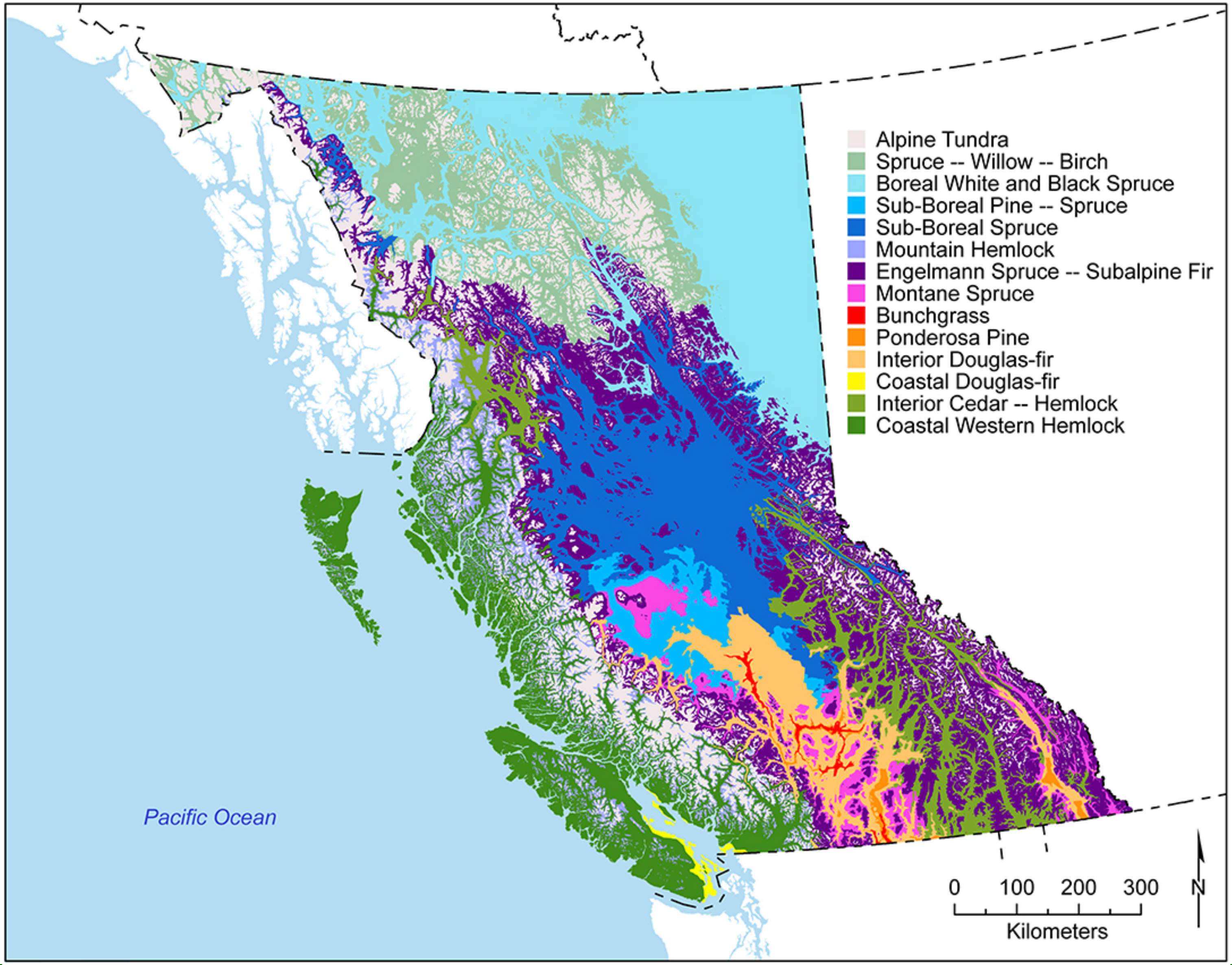
USDA Forest Service, Pacific Northwest Research Station

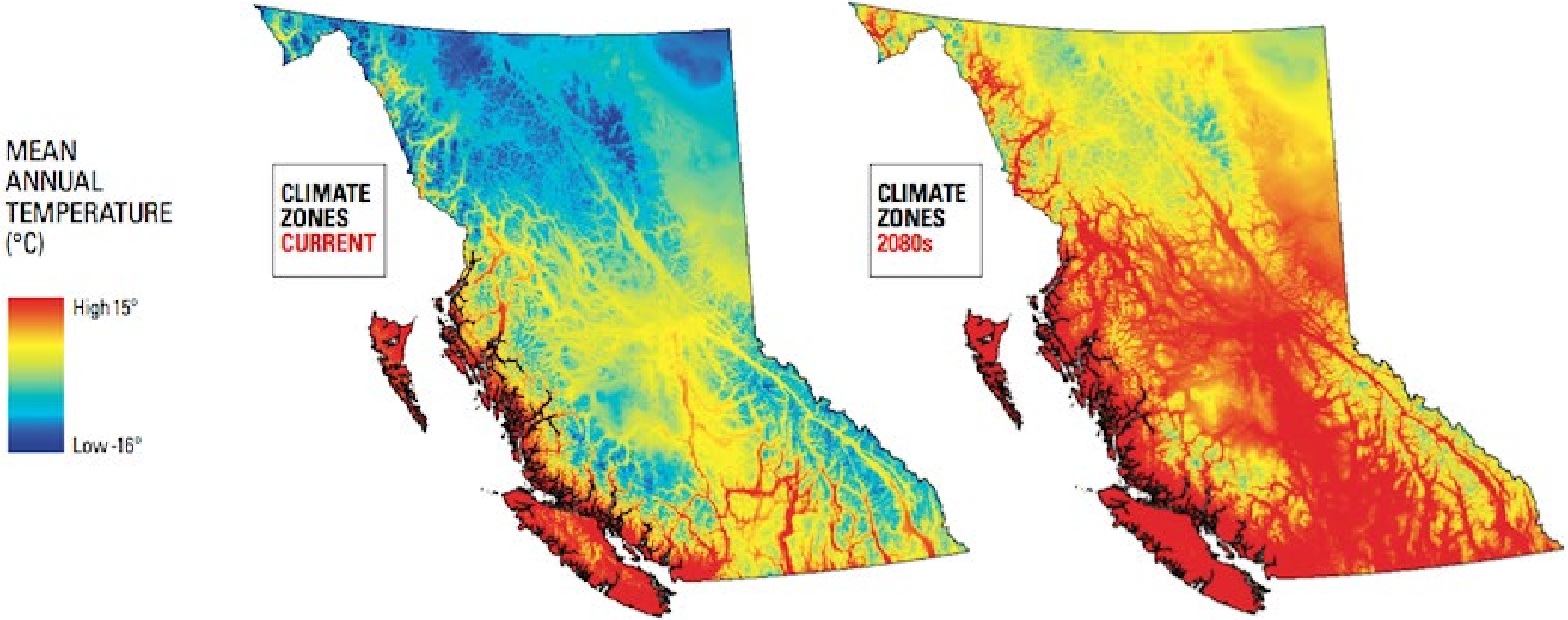
CHANGING WILDFIRE AND CLIMATIC REGIMES:
RESTORING RESILIENCE AT STAND TO LANDSCAPE SCALES

Paul Hessburg, Senior Research Ecologist, *paul.hessburg@usda.gov*

Engaging for Success, Striving for Resilience, St. Eugene Resort and Casino, Cranbrook, BC, Canada

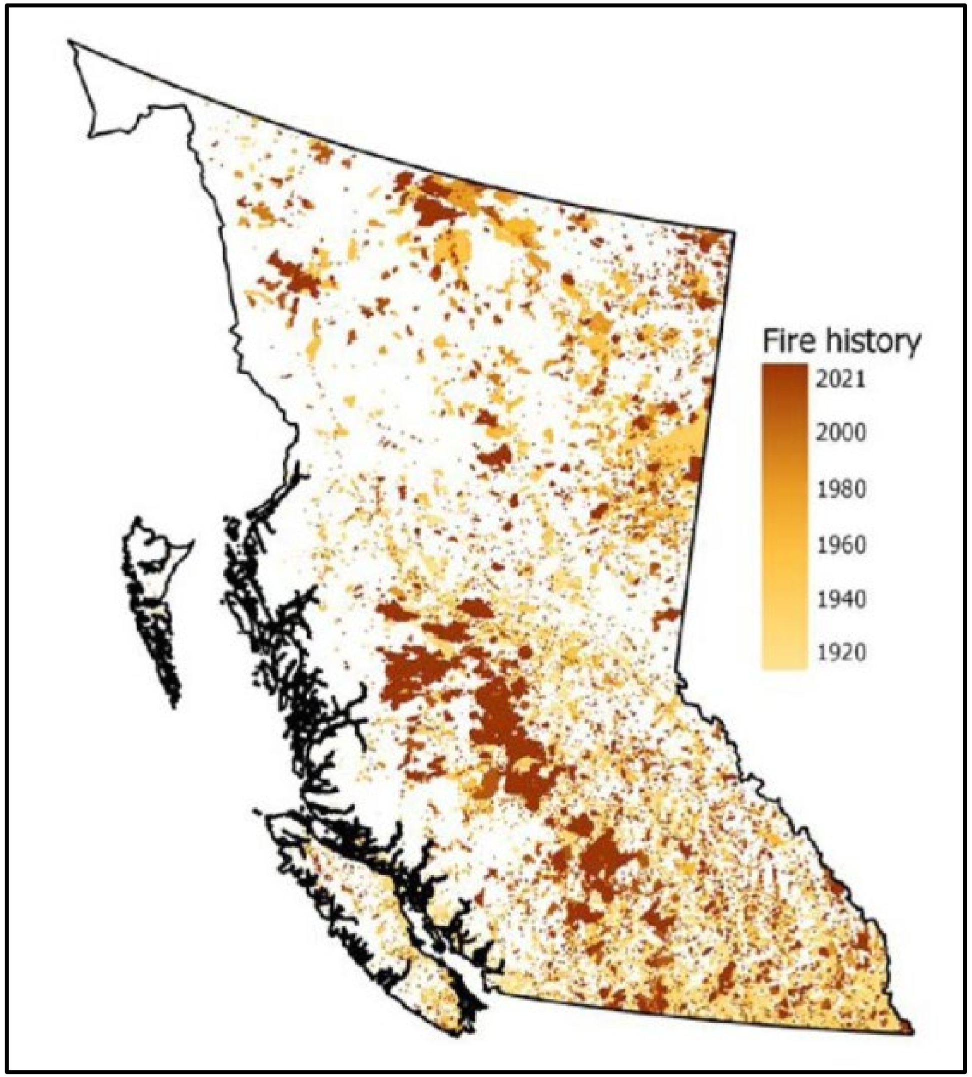


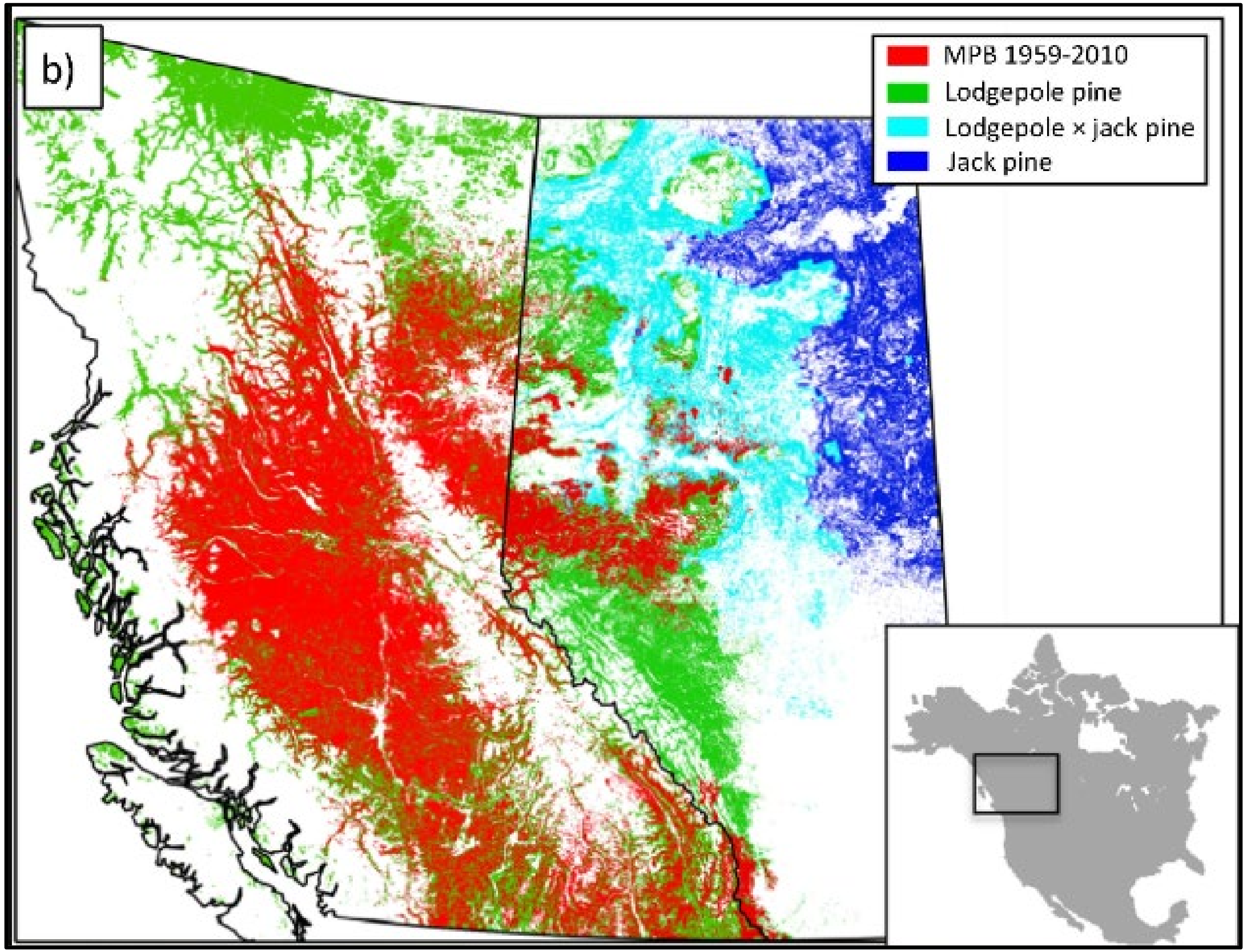
Alpine Tundra
Spruce -- Willow -- Birch
Boreal White and Black Spruce
Sub-Boreal Pine -- Spruce
Sub-Boreal Spruce
Mountain Hemlock
Engelmann Spruce -- Subalpine Fir
Montane Spruce
Bunchgrass
Ponderosa Pine
Interior Douglas-fir
Coastal Douglas-fir
Interior Cedar -- Hemlock
Coastal Western Hemlock
Pacific Ocean
0 100 200 300
Kilometers
N



SOURCE: TONGLI WANG, CENTRE FOR FOREST CONSERVATION GENETICS, UBC

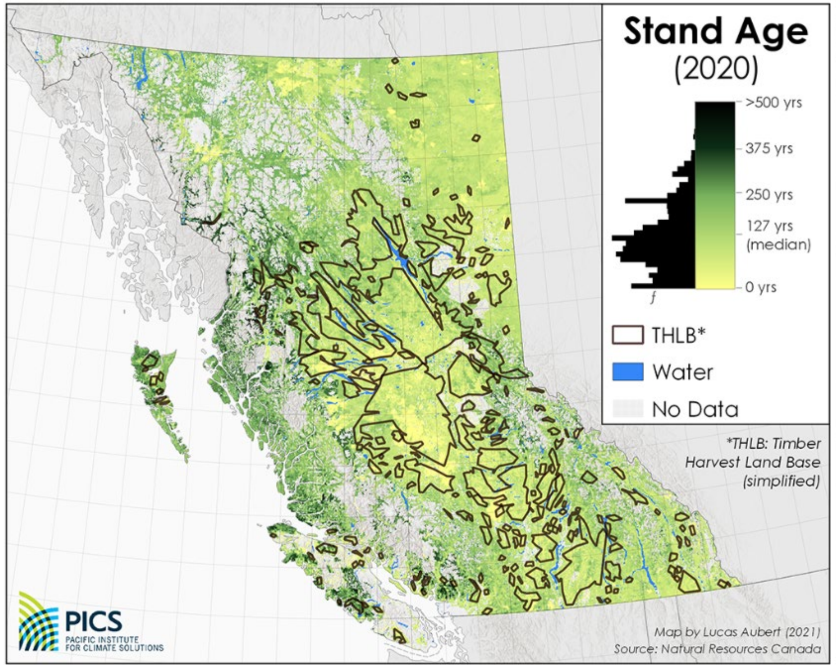
Wang et al. 2016; https://doi.org/10.1371/journal.pone.0156720

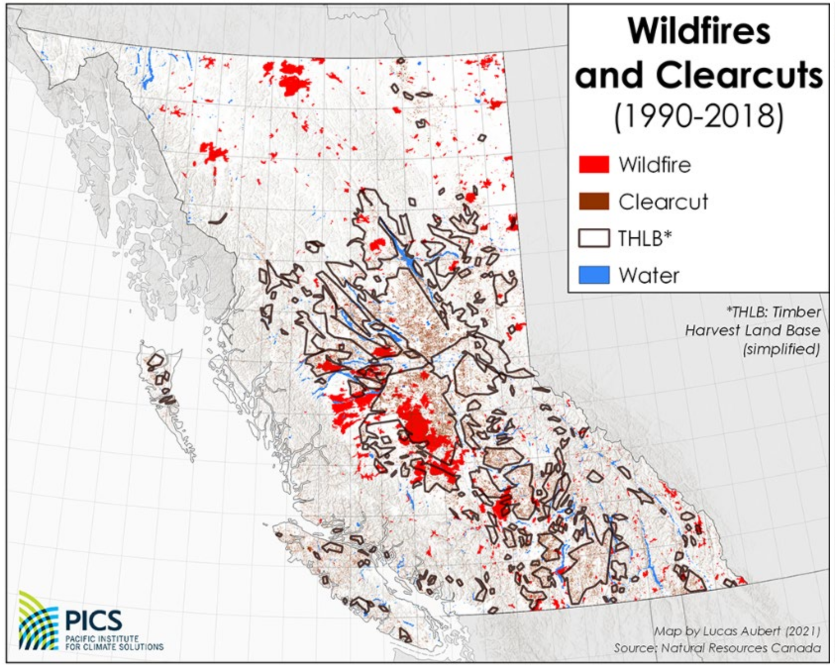


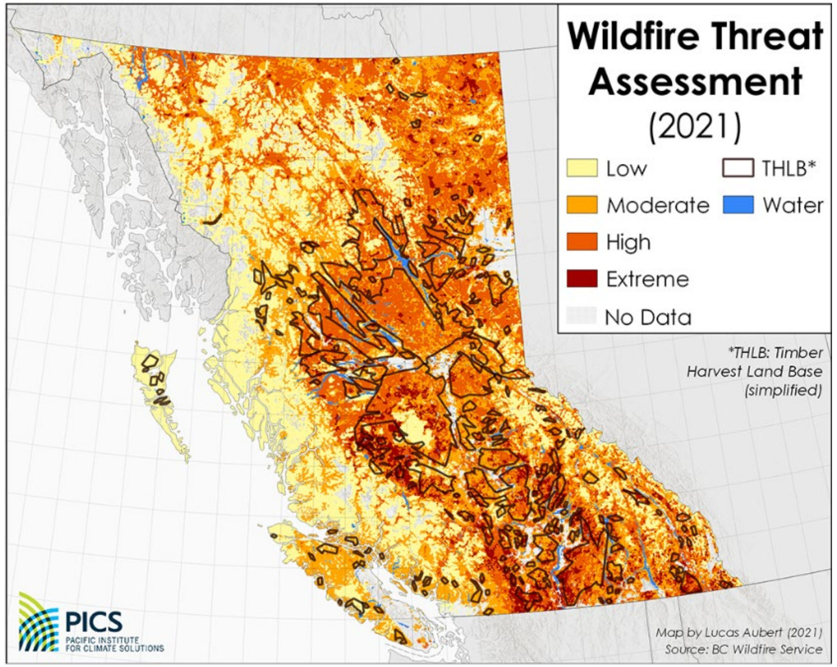


SW Taylor et al. 2022. https://doi.org/10.4095/330530
Baron et al. 2022. https://doi.org/10.1007/s10980-022-01506-9

Cooke and Carroll. 2017. https://doi.org/10.1016/j.foreco.2017.04.008

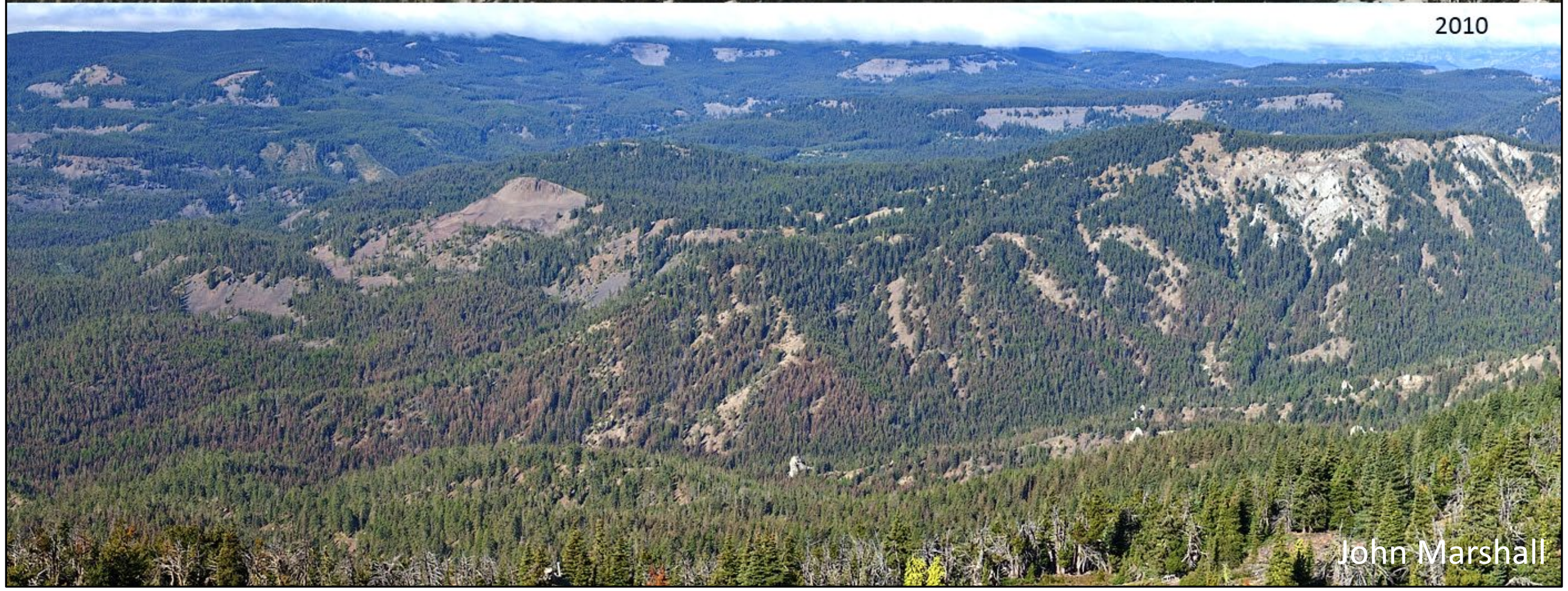






Albert Lucas, BCWFS & PICS

Frequent fire
(2-15 yrs)
Dry forests



An important local stabilizing feedback

Frequent low- or moderate-severity fire…

…leads to more of the same forest condition and future fire severity

(Povak et al. 2023, Prichard et al. 2017)

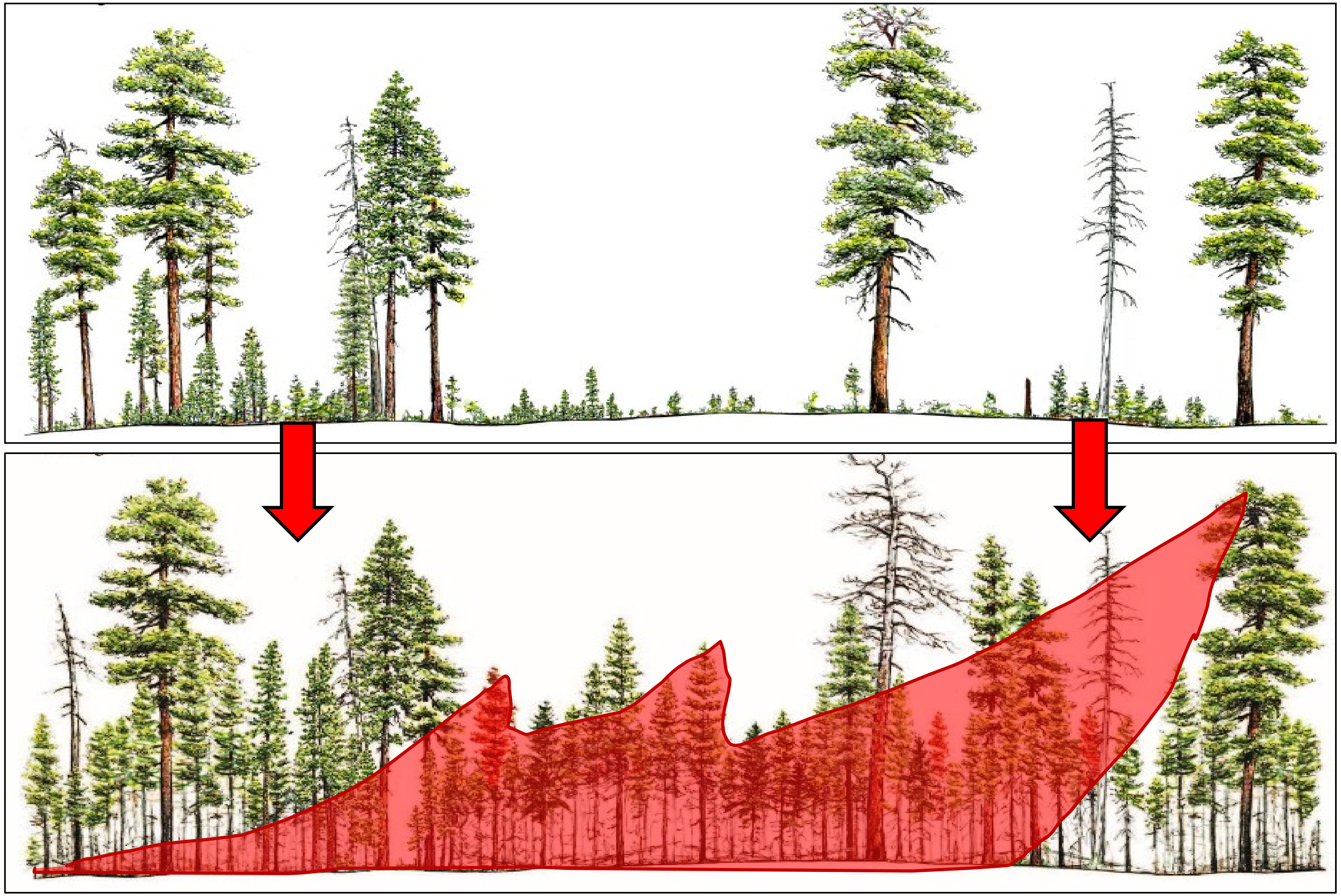
Bob Van Pelt drawing

Lacking these high frequency fires

Trees quickly accumulate

Flames can now "*climb*" the layered subcanopy

Resulting in crown fires

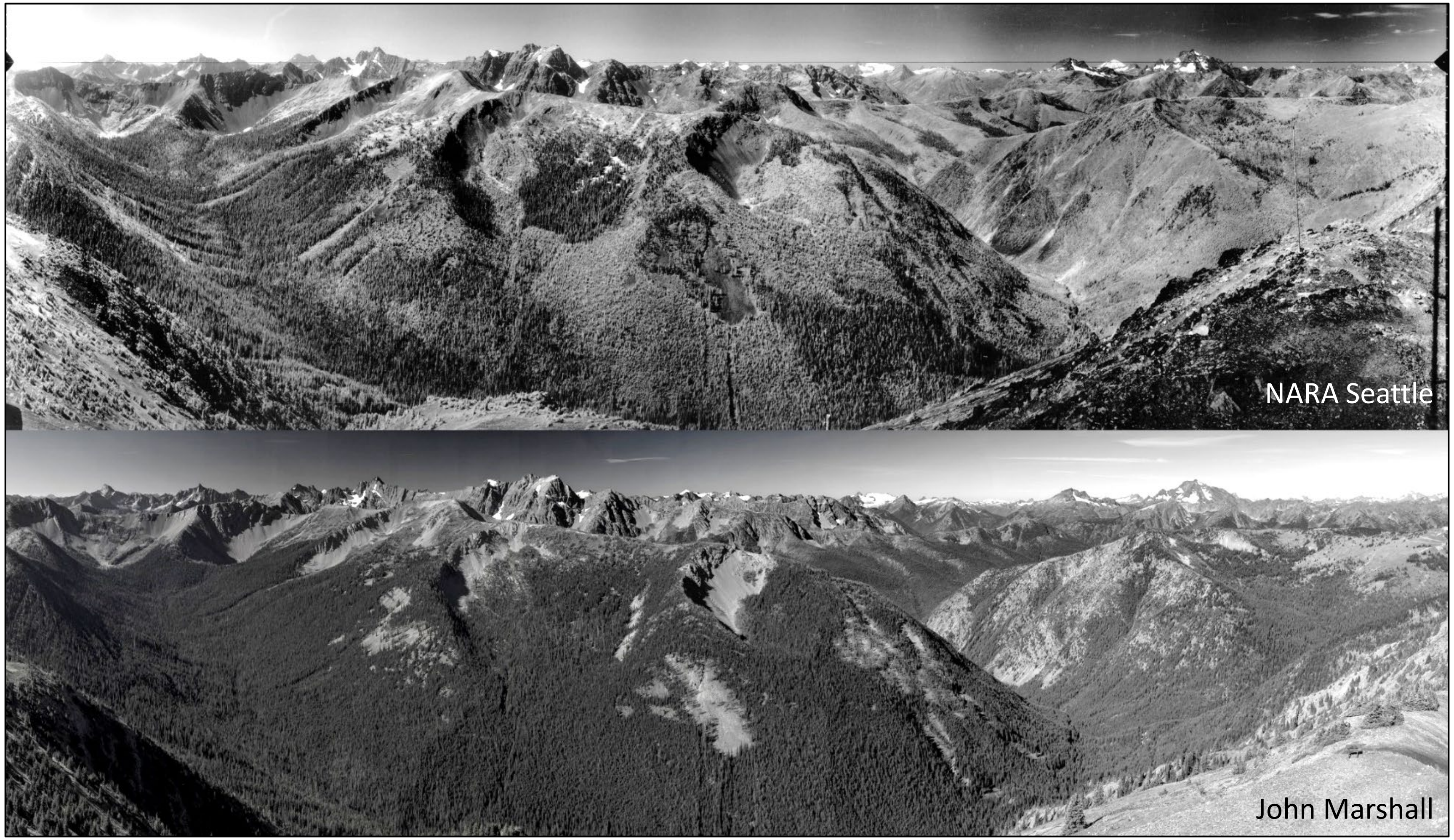


Bob Van Pelt drawing

Moderate frequency fire
(20-50 yrs)
Moist forests

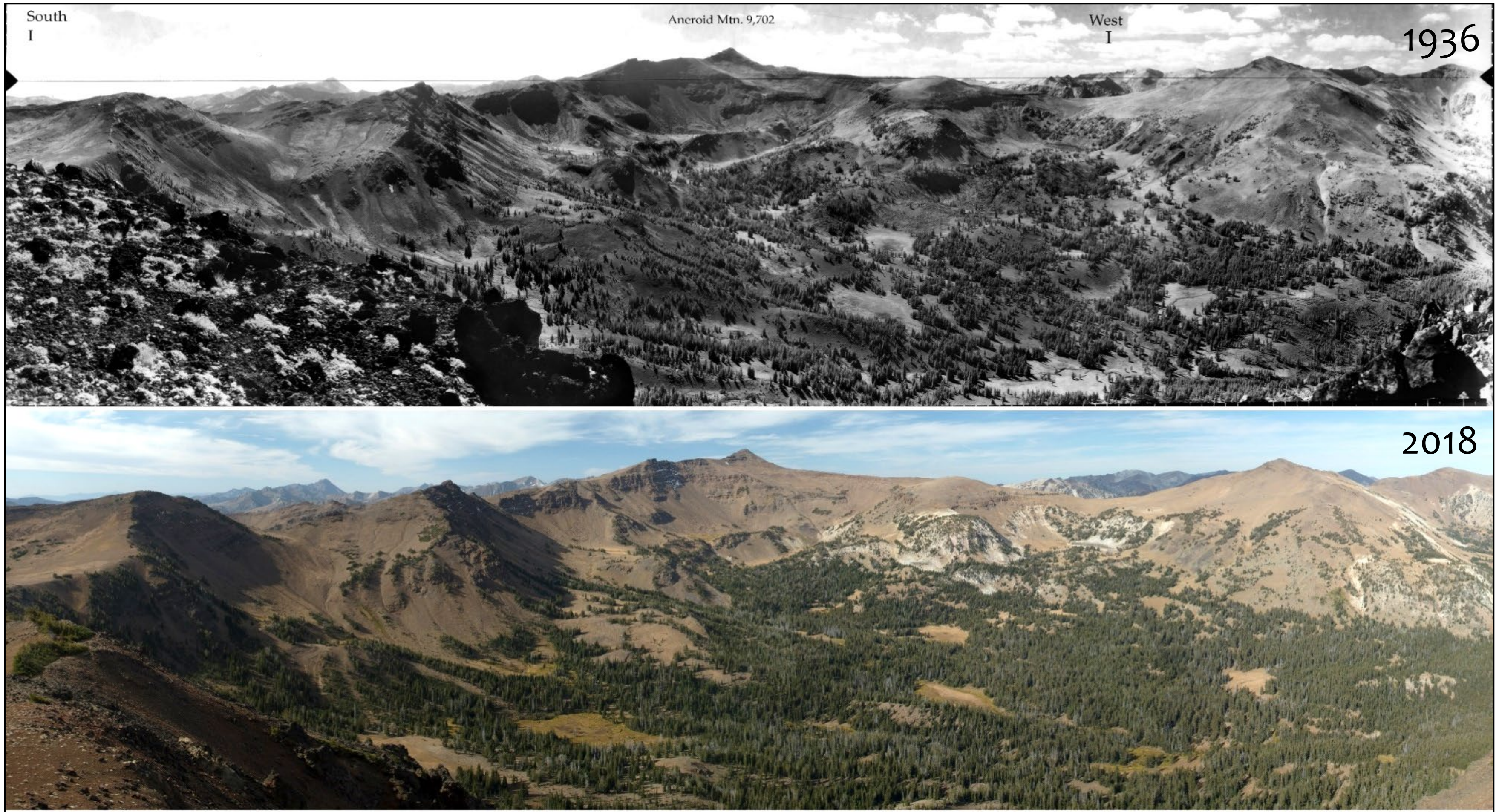
Fuel provides the energy for burn severity

Infrequent fire
(30-150 yrs)
Cold moist forests



High connectivity of dense forest provides the means for large, severe fires

Infrequent fire (30-150 yrs) Cold dry forests



Top Photo: 09/07/1936, U.S. Forest Service
National Archives and Records Administration, Seattle, WA
Osborne Panorama- 120 degrees

Historical Photographic Comparison from Red Mtn.
Eagle Cap Wilderness, Wallowa Mountains, Oregon
Copyright 2018 John F Marshall

Bottom Photo: John F Marshall 09/18/2018
From 9,000 feet overlooking McCully Basin

High connectivity of dense forest provides the means for large, severe fires

1936

2018

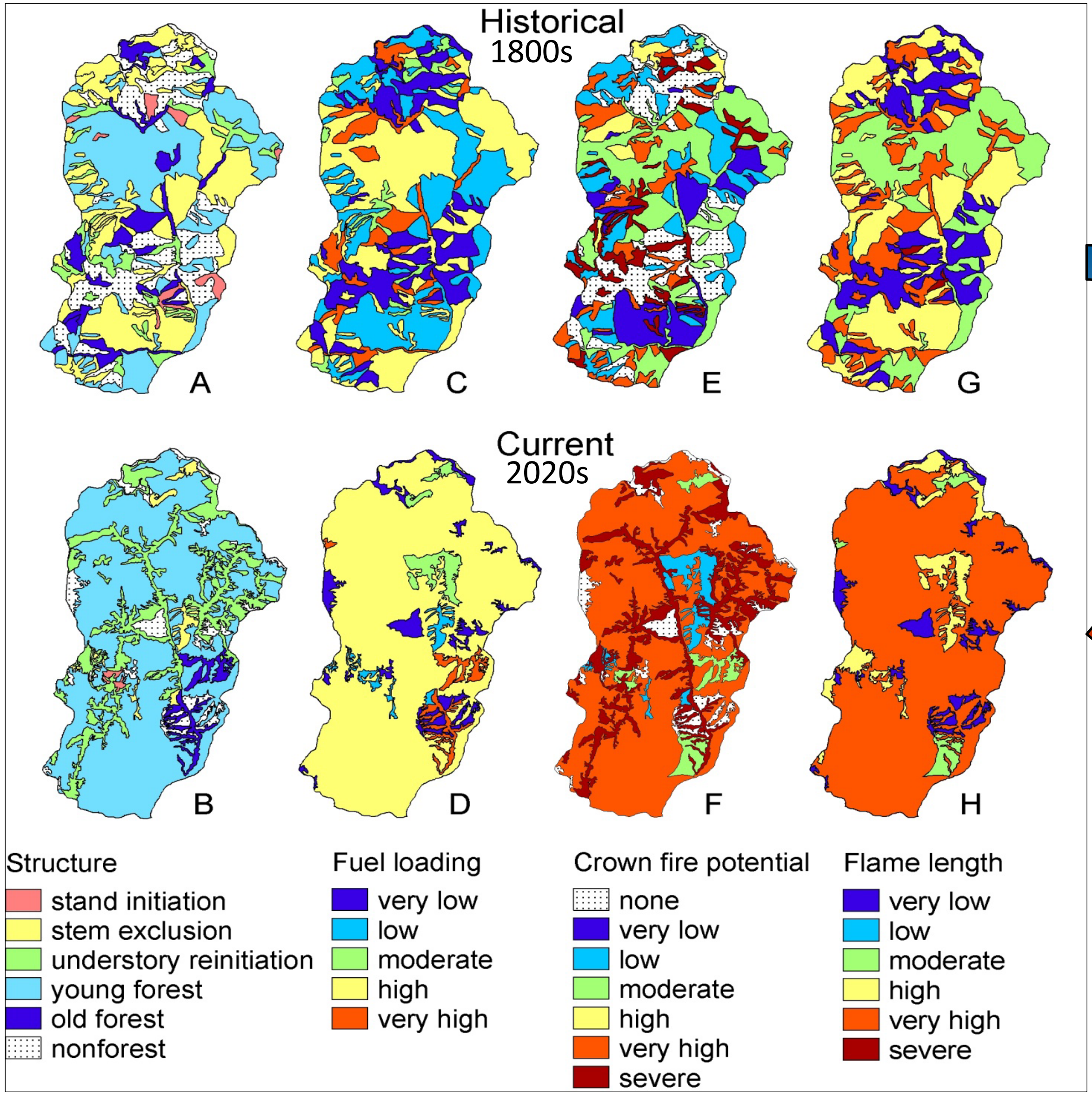
Top: U.S.Forest Service 1936
National Archives

McCully Creek, Wallowa Mtns.
Eagle Cap Wilderness, Oregon

Bottom: John F Marshall 2018

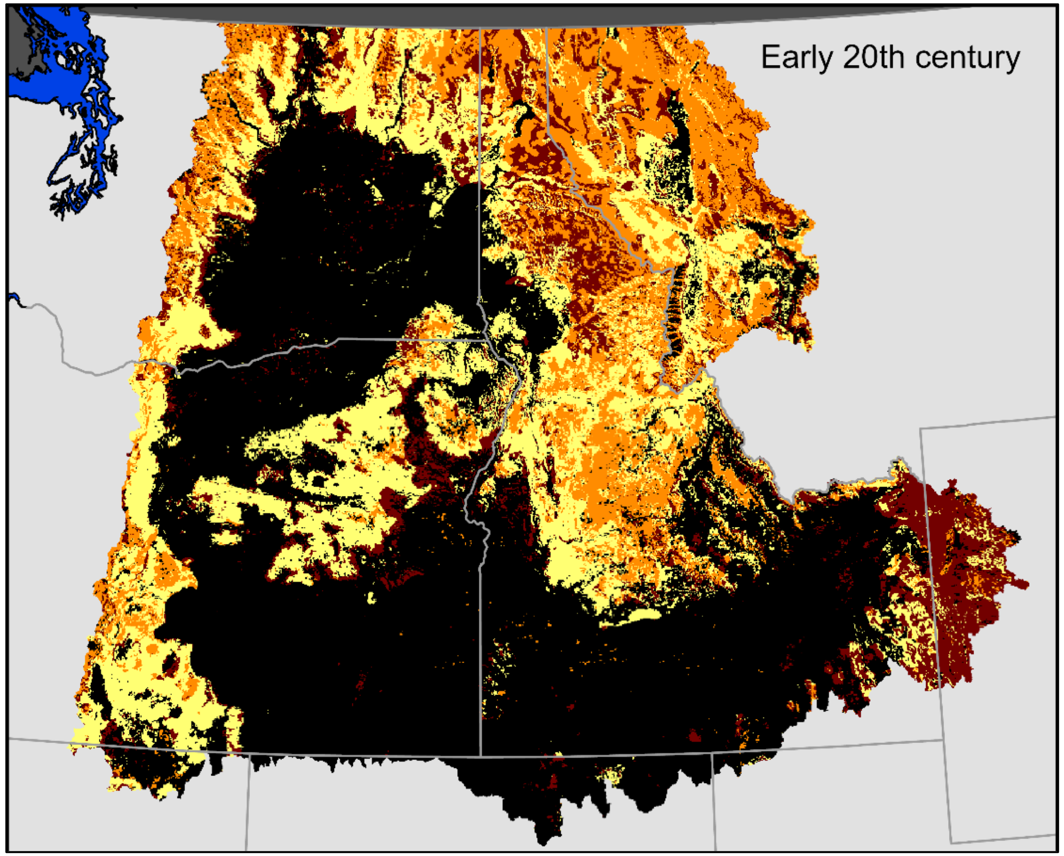
Forest Reburning was an essential large landscape stabilizing feedback

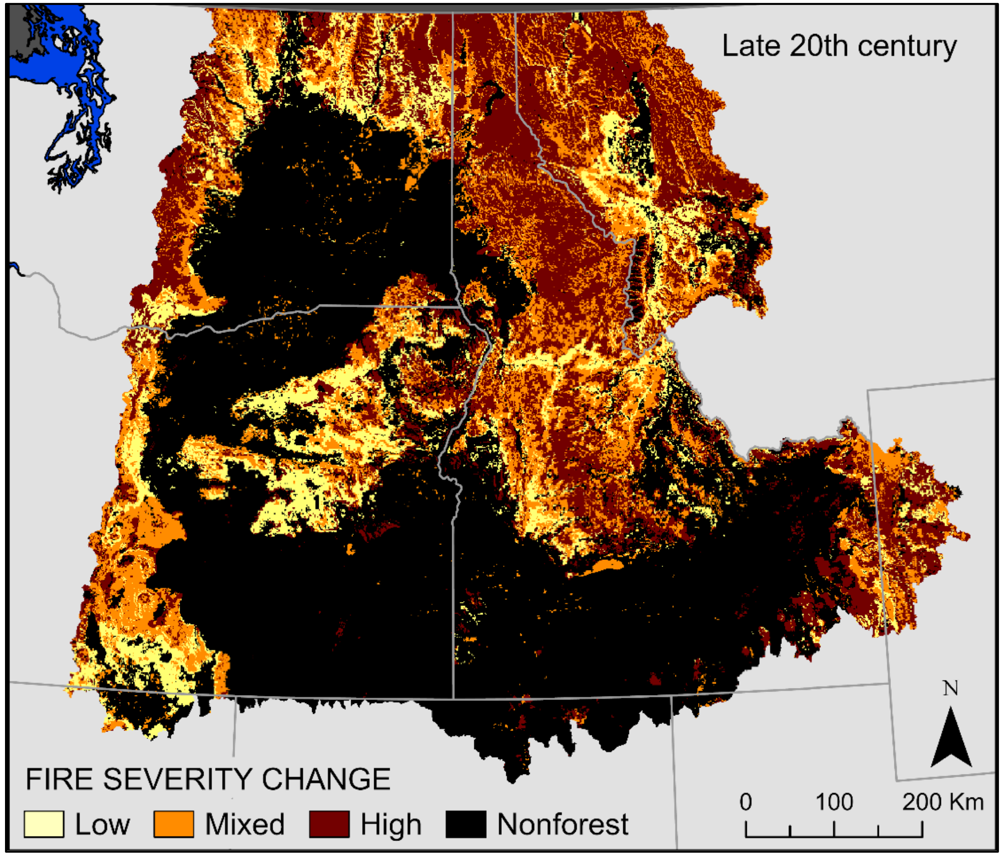
- Fires of varied size and severity created ever-shifting mosaics of non-forest & forest conditions
- Fires overlapped each other over space and time; i.e., forest reburning… removed surface fuels
- This shifting reburned and recovering mosaic regulated future fire size & removed, absent today
- It did so by halting or dampening fire spread, fire intensity, flame length, crownfire potential
- Resilient forest landscapes were less forested than we think
- Current forest cover and carbon references for interior wUS are unsustainable (Hessburg et al. 2019)



COMPARE TOP-BOTTOM MAP ROWS

- Increased surface and canopy fuels provide the energy for severe fires
- Increased connectivity of fuels creates the opportunity for large spreading fires
- Change in climate and weather drives fuel curing & area burned
- These conditions are well-connected over very large areas





- This is the interior Columbia River Basin in the US, ~60 MM ha
- Early 20th century, modeled fire severity is mostly low and mixed (moderate), **Left**
- Early 21st century, modeled fire severity is mostly high and mixed, **Right**
- High contagion of high burn severity conditions at regional to provincial scales

NONFOREST CONDITIONS & RESILIENT LANDSCAPES

- ✓ Much nonforest historically, 25-75% of area
  - Burned bare ground, early seral conditions
  - Nonforests: sparsely treed woodlands, meadows, prairies, shrublands, wetlands
- ✓ These features limited future fire size/severity
  - Tug-o-war btw factors growing/burning forests
  - Nonforests were the emergent property
- ✓ With CC, this intensifies, we can aid transitions
- ✓ How did we get here?

Key change agents

Pre-1850 → 2023

Fire exclusion – Curtailed Indigenous burning, drained wetlands, livestock grazing, development-built env., fire suppression

Timber harvest – Logging Lg-old trees, smaller trees filled in, limited Rx burning after harvests, dramatically reduced hardwoods

Bark beetles – Large outbreaks; accelerated salvage, limited Rx burning after salvage, salvaged ~1/3, continued outbreaks

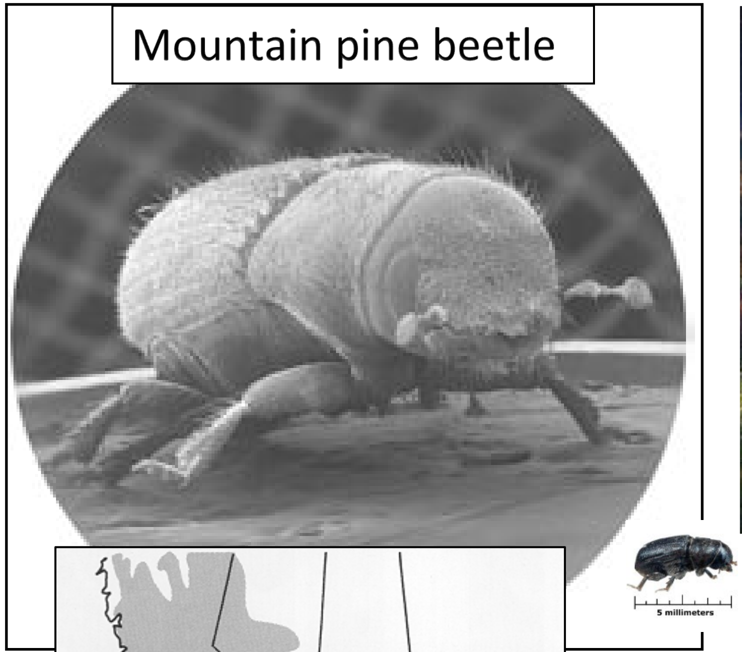
Climate change – Warmer, drier, windier, longer fire seasons, less snowpack, warmer winters, > lightning & human starts

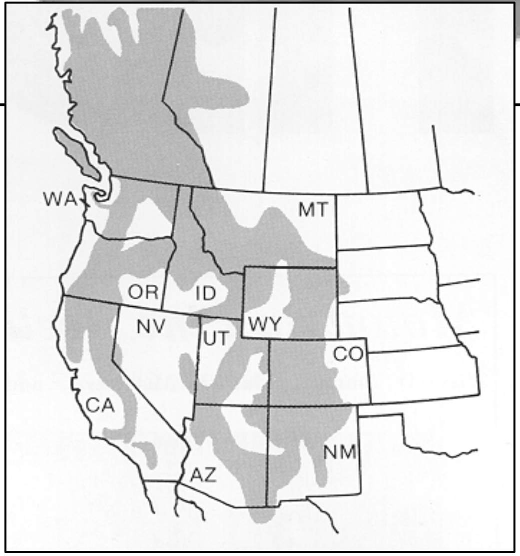
Frequent fires in dry and moist forests continually thinned forest patches, reducing density & fuels, increased the likelihood that the next fire was also low severity

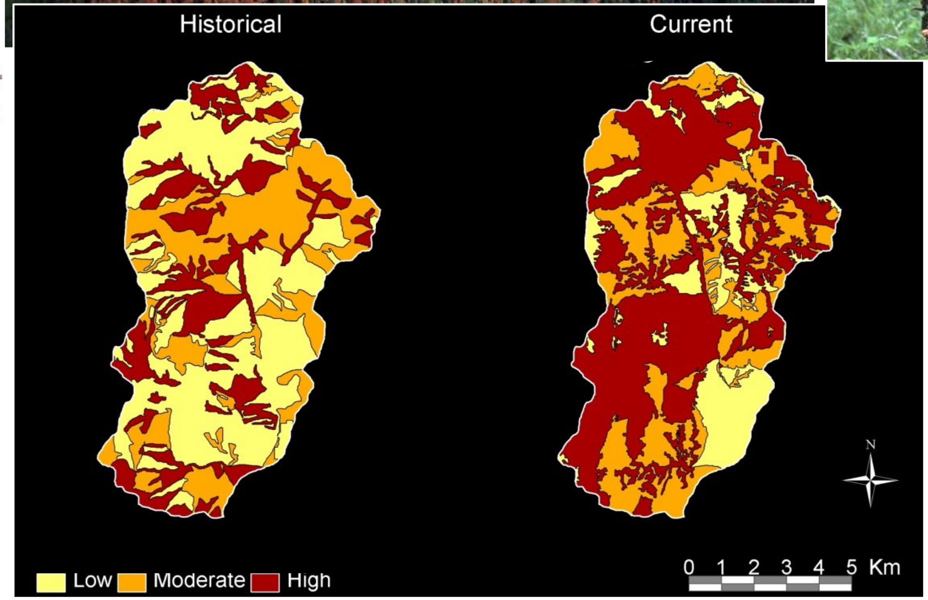
Stand stabilizing feedback

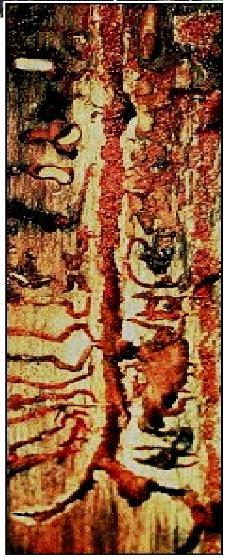
Moderate and high severity fires created patchworks of nonforest, young, middle-aged and older forest, open vs closed canopy conditions, hardwood patches: these patterns reduced future fire size & severity, affecting ROS, FL, FLI

Landscape stabilizing feedback







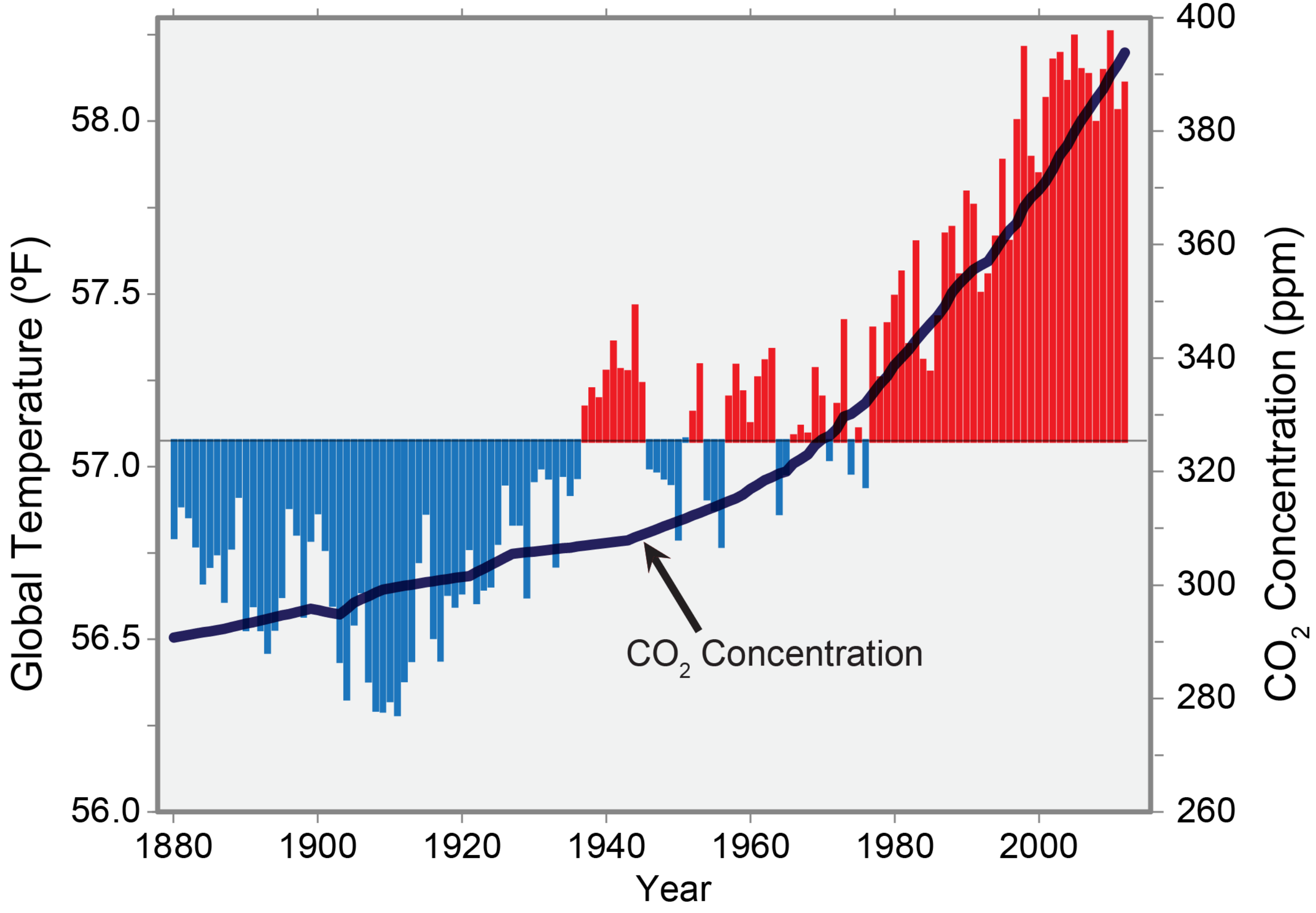


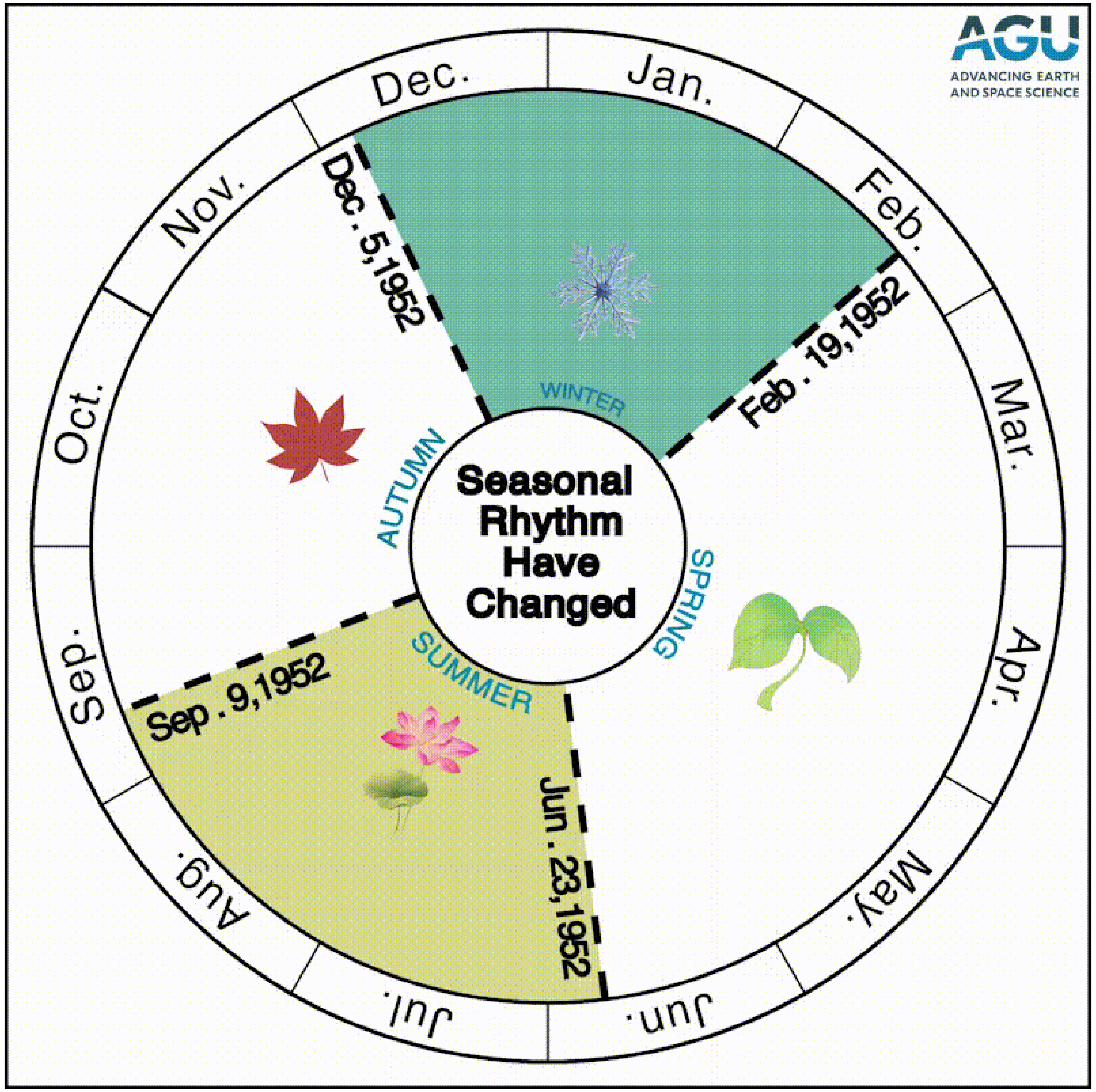
Loss of variable patchwork, warmer winters, larger/longer outbreaks

A WARMING CLIMATE

More extreme climate & fire weather currently drives large burned area

Global Temperature and Carbon Dioxide





Northern Hemisphere summers projected to last nearly half of the year by 2100!

A CENTRAL RESILIENCE ROLE FOR HARDWOOD FORESTS

- ✓ Hardwood patches historically widespread
- ✓ Limited future fire size & severity, wet blanket effect
- ✓ Tug-o-war btw factors growing forests & fires killing them
  - Hardwood forests were also an emergent property

Landscape Ecol (2015) 30:1805–1835
DOI 10.1007/s10980-015-0218-0

CrossMark

REVIEW ARTICLE

Restoring fire-prone Inland Pacific landscapes: seven core principles

Paul F. Hessburg · Derek J. Churchill · Andrew J. Larson · Ryan D. Haugo · Carol Miller · Thomas A. Spies · Malcolm P. North · Nicholas A. Povak · R. Travis Belote · Peter H. Singleton · William L. Gaines · Robert E. Keane · Gregory H. Aplet · Scott L. Stephens · Penelope Morgan · Peter A. Bisson · Bruce E. Rieman · R. Brion Salter · Gordon H. Reeves

Hessburg et al. 2015. https://doi.org/10.1007/s10980-015-0218-0

Principle 1

Landscape resilience is layered, to re-acquire multi-layered functionality, we rebuild:

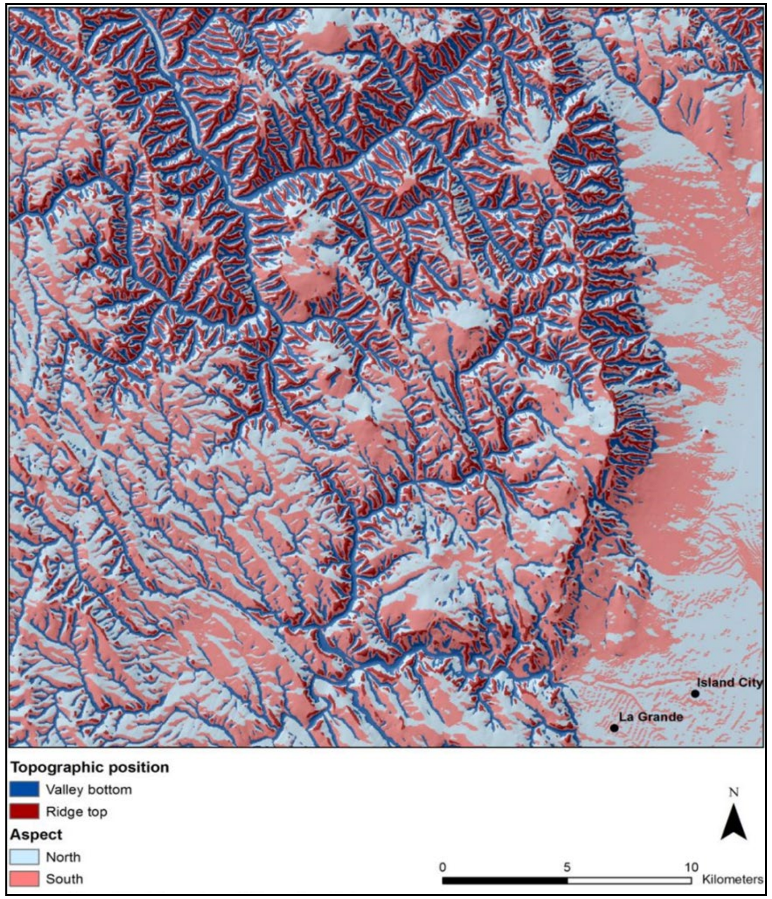
- Broad patterns of nonforests & forests, 10,000 ha
- Intermediate-scale: vary forest age, species composition, density, nonforest patches, 1,000 ha
- Fine-scale -- vary forest and nonforest conditions by varying tree clump & gap patterns w/in forest patches, 10-100 ha

Hagmann et al. 2021. https://doi.org/10.1002/eap.2431
Hessburg et al. 2015. https://doi.org/10.1007/s10980-015-0218-0

Principle 2

Topography provides a natural template for restoring fire-adapted vegetation & habitat patterns

- ✓ Use it to fit tree age, density, species, lifeform, tree clump & gap patterns to the landscape



Principle 3

Fire-climate-topography interactions drive forest conditions that maintain a desirable active fire regime

- ✓ Restore forest age, density, fuel & species composition patterns that support that regime
- ✓ The climate and wildfire will continually adapt these patterns, fire is inevitable, invite good fire back

Principle 4

Predictable forest patch sizes emerged from historical vegetation-fire interactions

- ✓ To re-acquire resilience, use the topography to re-align vegetation patch sizes to the terrain
- ✓ Contrast w/ current homogeneous patch sizes, shapes, arrangements

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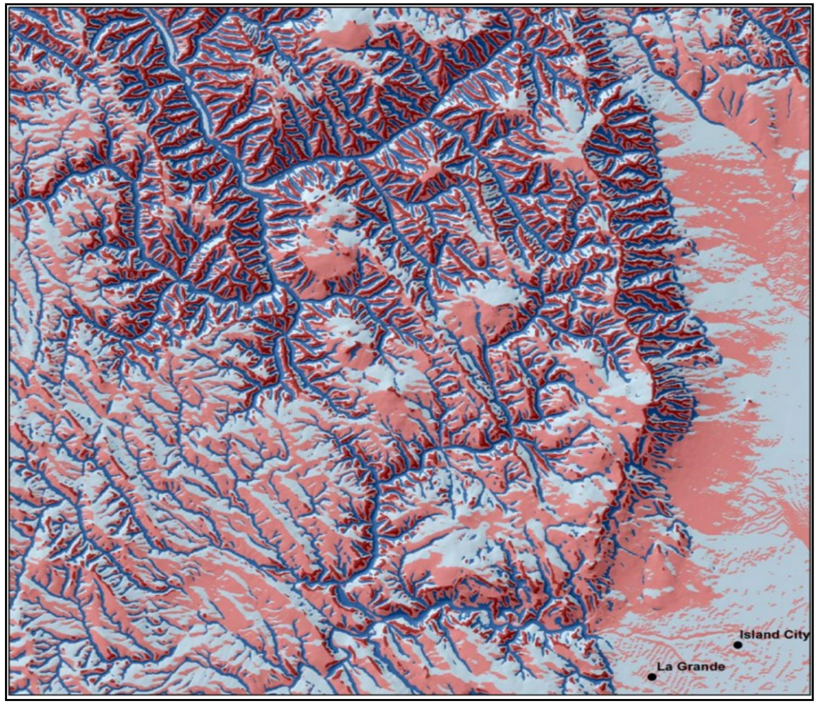


Moritz et al. 2011. Landscape Ecology of Fire, Springer

Principle 5

Widely distributed large old trees & old forests provide a critical backbone to dry PP IDF, & MMC forest landscapes; CC & wildfire adapted, vital to storing genetic material, habitat

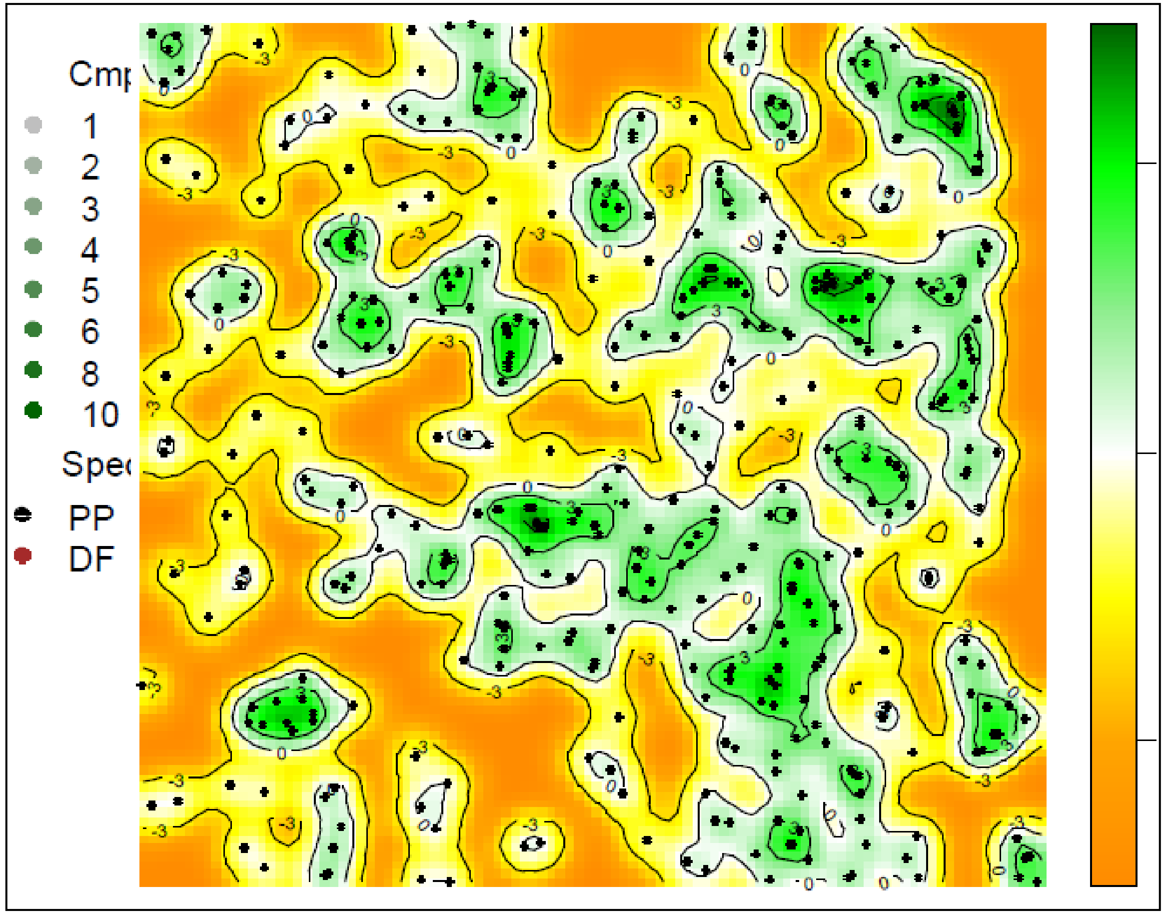
- ✓ To re-acquire this fine- to meso-scale resilience, protect what you have, grow more of them

Lutz et al. (2009) For Ecol Manage 257: 2296-2307; Hagmann et al. (2013) For Ecol Manage 304: 492-504
Hagmann et al. (2014) For Ecol Manage 330: 158-170; Larson & Churchill (2012) For Ecol Manage 267: 74-92
Churchill et al. 2013. For Ecol Manage 291: 442-457.

Principle 6

Forest patches function as small landscapes w/in their larger landscape

- ✓ To re-acquire this resilience to PP, IDF, DMC, MMC, restore tree clump & gap variation
- ✓ Take the canopy cover down, vary tree clump and gap sizes
- ✓ Maintain this over time
- ✓ It will constantly shift w/ disturbance
- ✓ This controls patch level fire behavior



Larson & Churchill (2012) For Ecol Manage 267: 74-92
Churchill et al. (2013) For Ecol Manage 291: 442-457
Lydersen et al. (2013) For Ecol Manage 304: 370-38
Clyatt et al. (2016) For Ecol Manage 361: 23-37
LeFevre et al. (2020) For Sci 66: 578-588

Principle 7

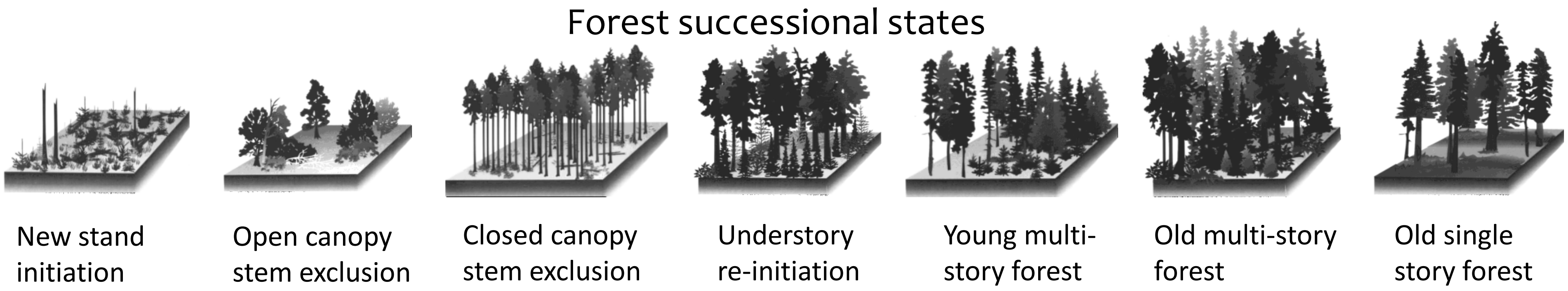
Land allocation & ownership patterns disrupt functional landscapes & the role of topography

- ✓ With CC and wildfires, land management allocations, ownerships won't protect conditions, they'll continually shift
- ✓ Use aspect, ridges, and valleys, work with your neighbors!

Cheng & Sturtevant (2012) Env Mgt 49:675-689; Rieman et al. (2015) Fisheries, 40:124-135

TAKE AWAYS

- ✓ Create nonforest & varied forest age & density conditions (successional states)
- ✓ Align w/ topography, reinforcing topographic controls on fire behavior
- ✓ Restore a primary role for hardwood forests, nonforests, & wetlands, we have tools, e.g., CWD tool
  - o Innovation is needed in the hardwood forest products sectors to handle more hardwood fiber



CWD = PET - AET

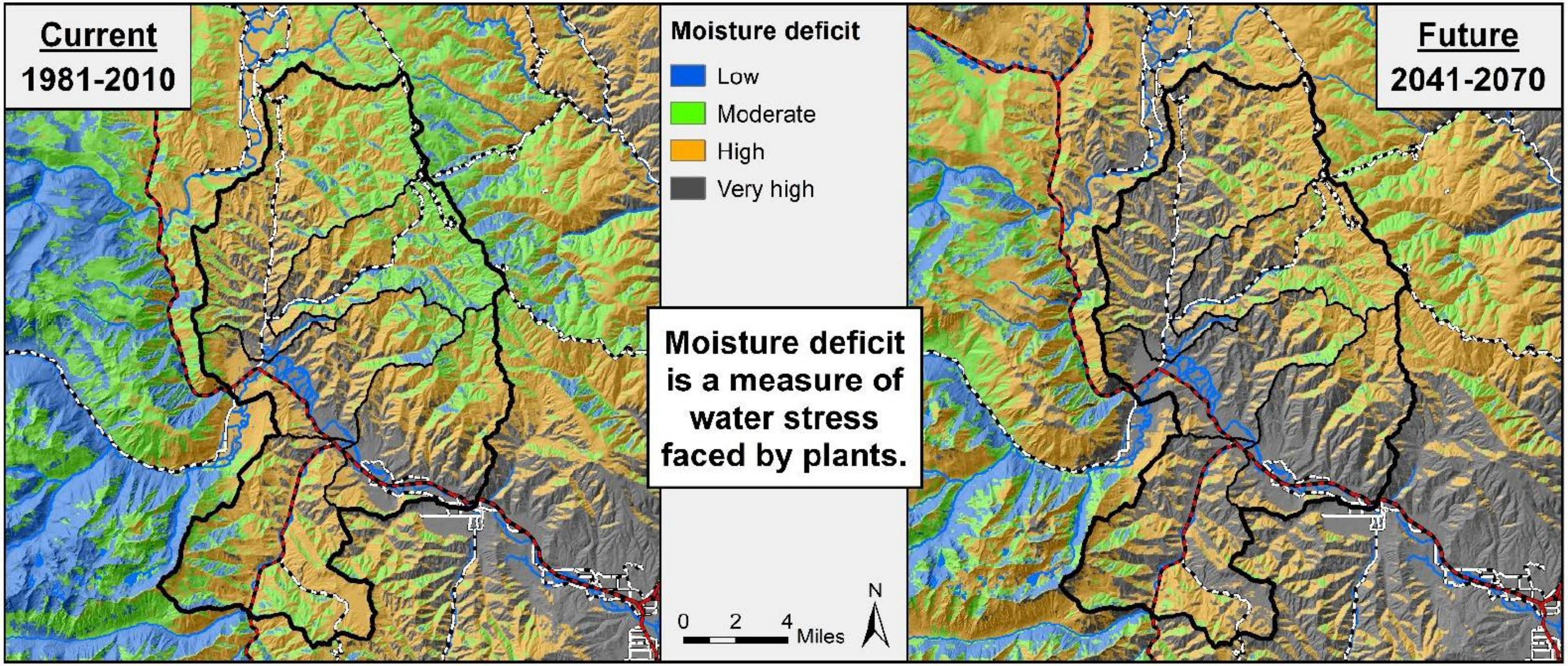
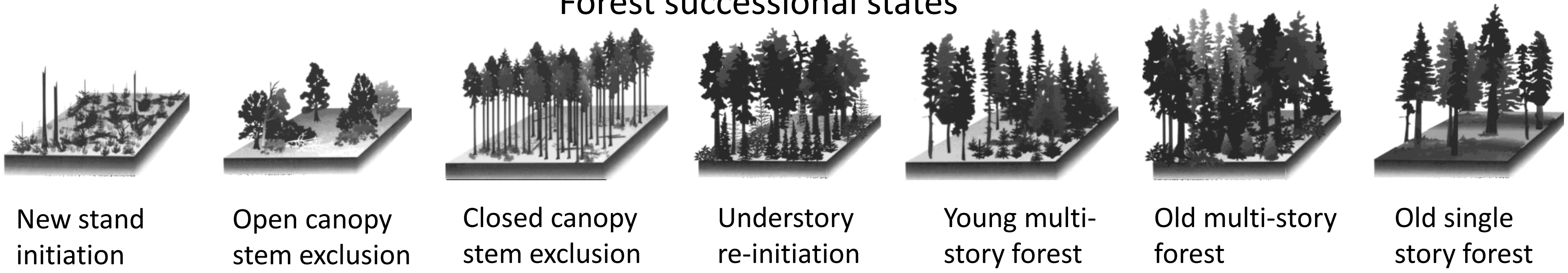


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

TAKE AWAYS

- ✓ Create nonforest & varied forest age & density conditions
- ✓ Align w/ topography, reinforcing topographic controls
- ✓ Restore a primary role for hardwood forests, nonforests, & wetlands, we have tools, e.g., CWD tool
- ✓ Thin + Rx fire, Rx fire, managed wildfire -- modified suppression once conditions allow fire re-entry
  - o This is a CULTURAL SHIFT in the scale of forest & project planning & management
- ✓ To be effective, scale & pace of the needed work must exceed the pace & scale of wildfires + CC
  - o > 40-50% of the landscape conditions need to be fire adapted, 100% for for woodlots
- ✓ Fiber utilization or Rx burning should follow adaptation treatments, or conditions likely worsen
  - o Biochar, hog fuel, bioenergy from wood chips, look for & support opportunities
- ✓ This is a transgenerational commitment, we take care of the system, it takes care of us.

Forest successional states



Effectiveness of different types of fuel treatments

Thinning alone

- Abundant slash, esp. if pre-commercial
- Lowest cost treatment when trees have value
- Future fire effects less well controlled

Thinning + Broadcast burning

- Hand pile slash concentrations, as needed
- Broadcast burn the remainder
- Good for the understory community
- Most effective hazardous fuel reduction
- Prepares mineral soil for fire tolerant spp.
- Spatially precise, fire effects most controlled

Rx burning alone

- No slash, nothing to hand pile
- Prepares mineral soil
- Fire effects harder to control
- Fire perimeter harder to hold
- Require more/longer staffing
- May get more/less mortality than desired
- No financial return, short run, high unit costs
- Maintenance burns required more often

Thinning + piling

- Abundant slash
- Most expensive to thin + hand pile
- Acres treated are small, labor intensive
- Sterilizes soil if large piles burned
- Least effective at protecting future stands

Shelterwood Regen Harvest

- Abundant slash
- High financial return
- Can treat large acres
- Pile concentrations, broadcast burn
- Effective at protecting future stands

Clearcut Regen Harvest

- Most abundant slash
- Highest financial return
- Can treat large acres
- Pile concentrations, broadcast burn
- Must replant, unless LPP
- Effective at protecting future stands

Thank you!