Anadromous and Coldwater Fish:

Fire-adapted and fire-dependent?

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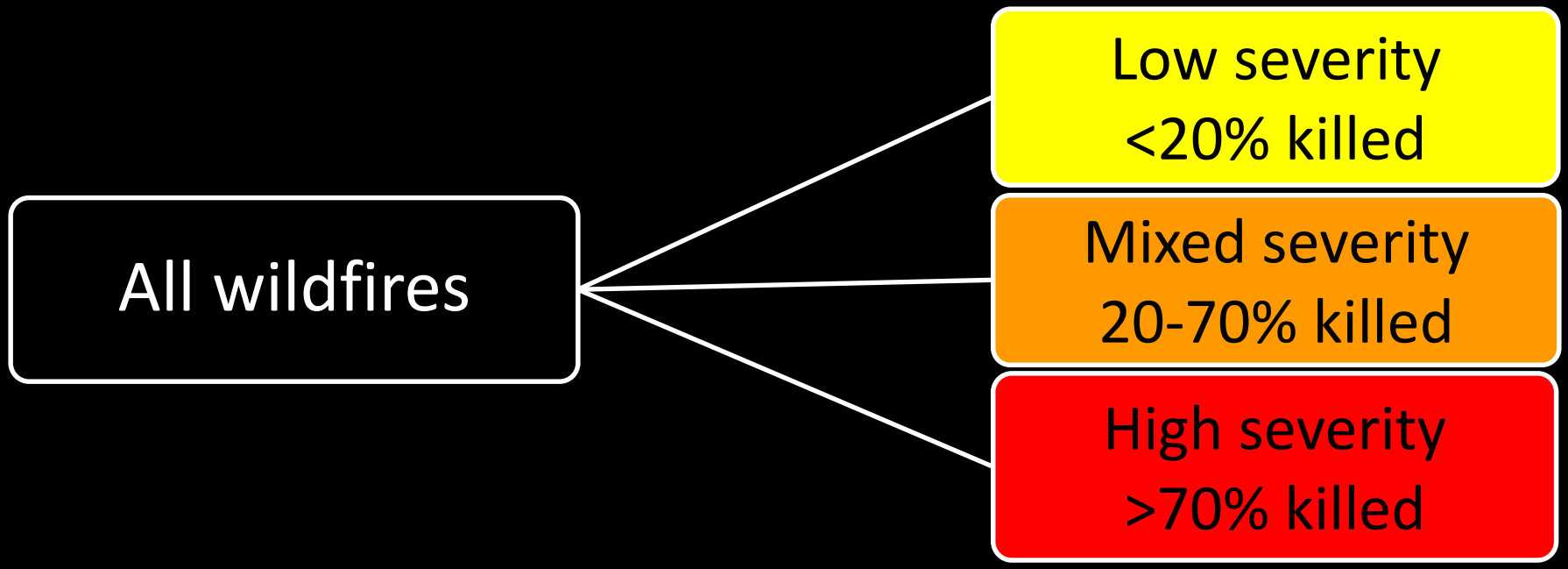
Prologue

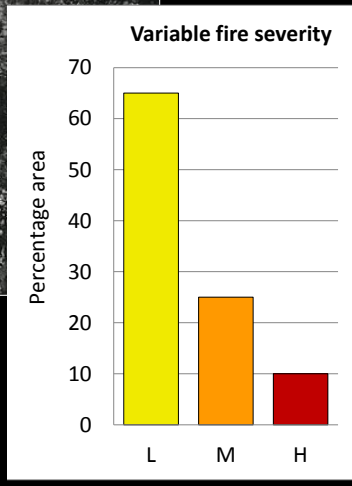
- Historical fire regimes, forest succession, their roles
- Mgt drove numerous terr/aqu system changes
- Climate is driving further changes
- Key principles emerging from study of changes
- Terr/aqu system mgt – decades of conflict
- Opportunities for convergent solutions

Historical fire regimes

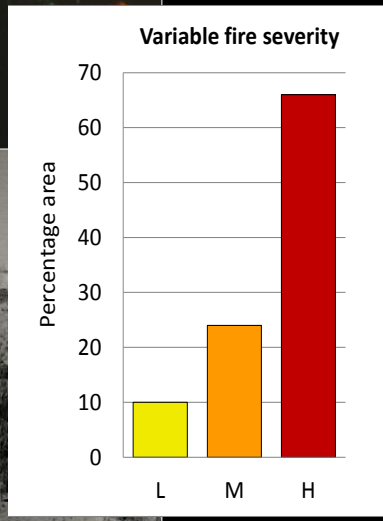
(varied by frequency, severity, seasonality, extent)



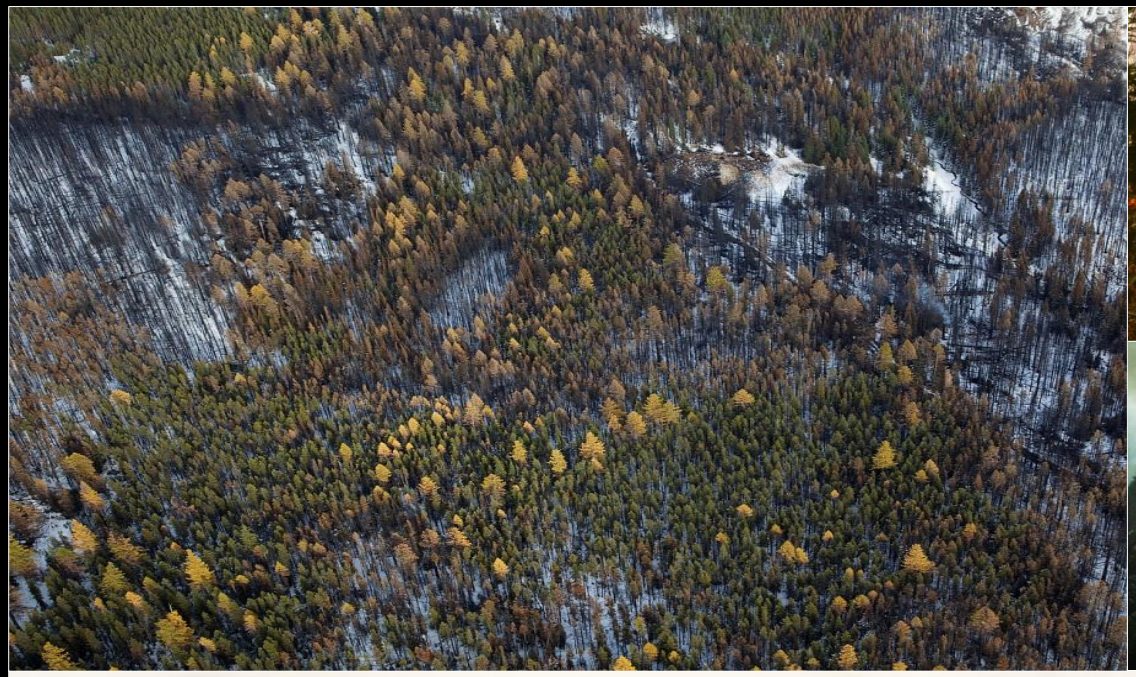
Low severity fire (LSF) – frequent fires, surface fire behavior
High severity fire (HSF) – infrequent fires, mostly crown fire behavior
Mixed severity fire (MSF) – moderately frequent fires, mixed crown + surface fires

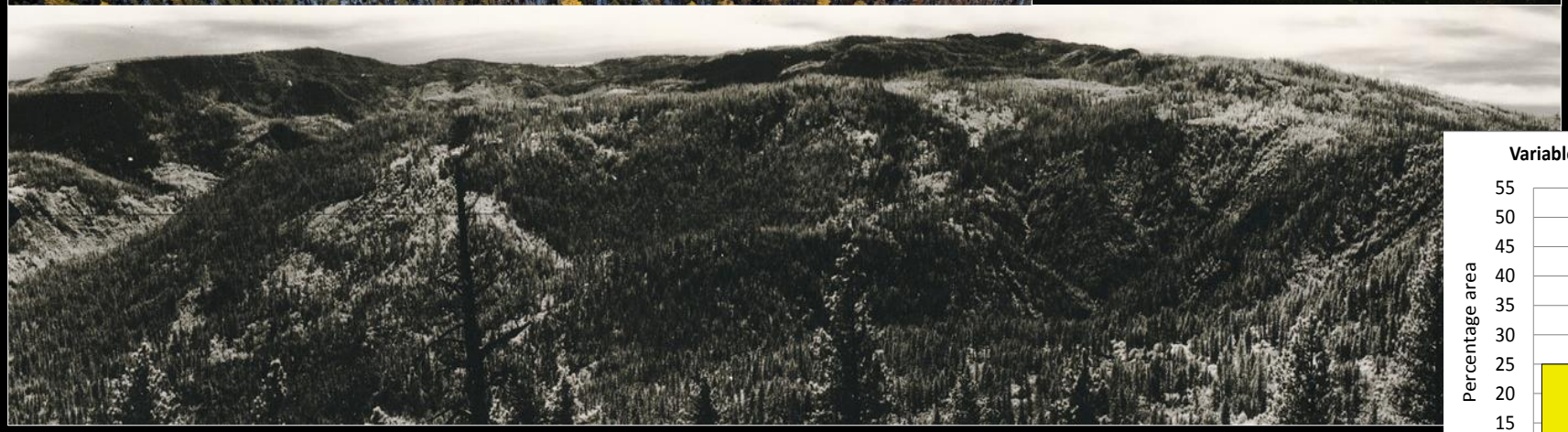


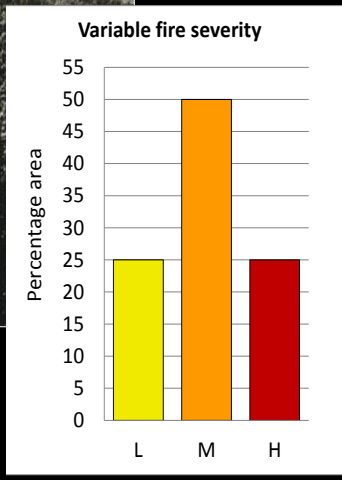
Low severity fire (LSF): <20% of the dominant tree cover killed by fire



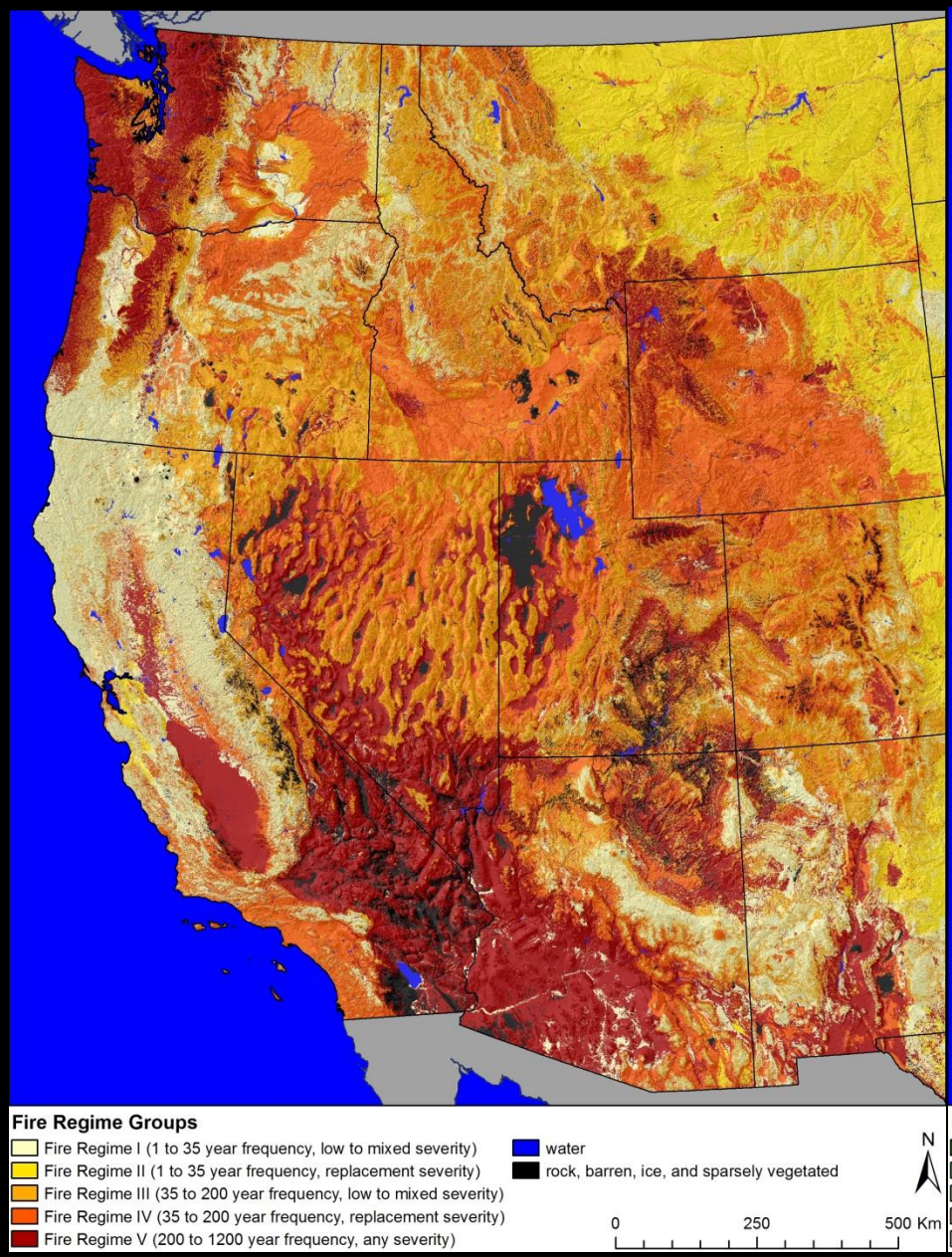
High severity fire (HSF): > 70% of the tree cover killed by fire



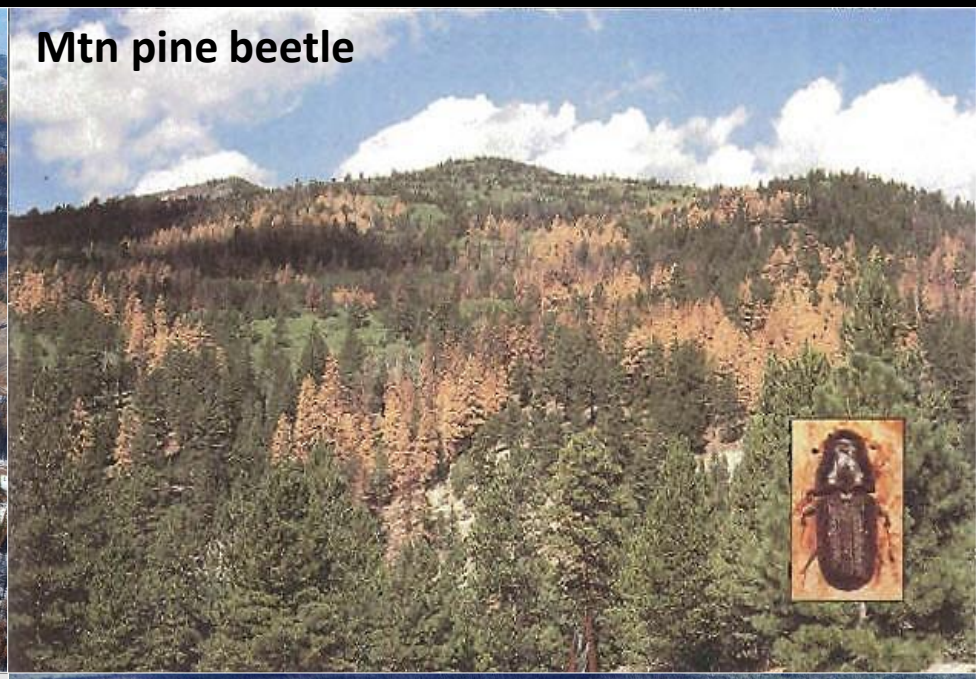


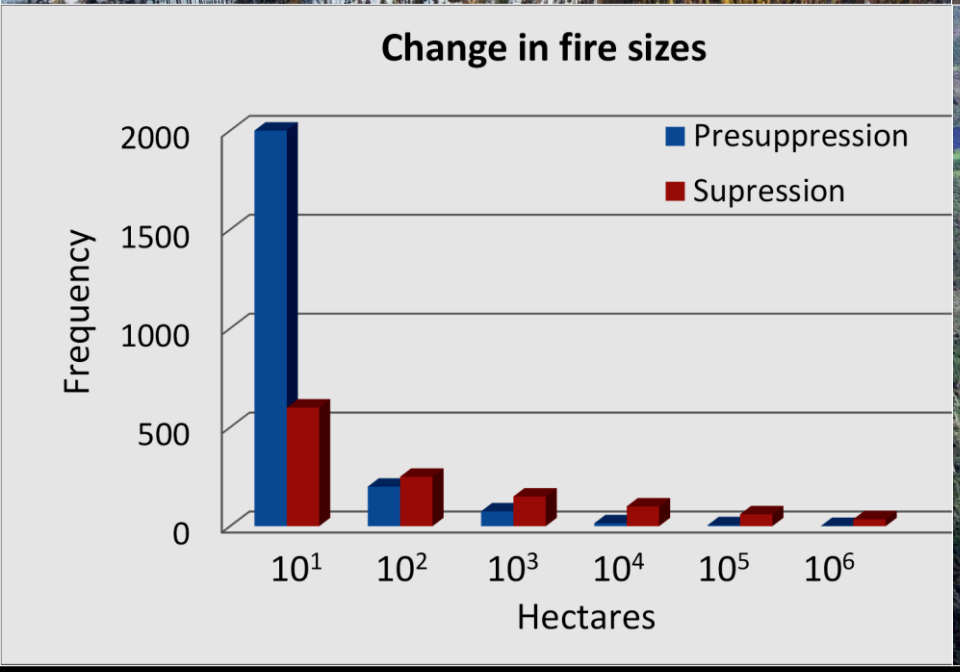


Mixed severity fire (MSF): 20-70% of the tree cover killed by fire



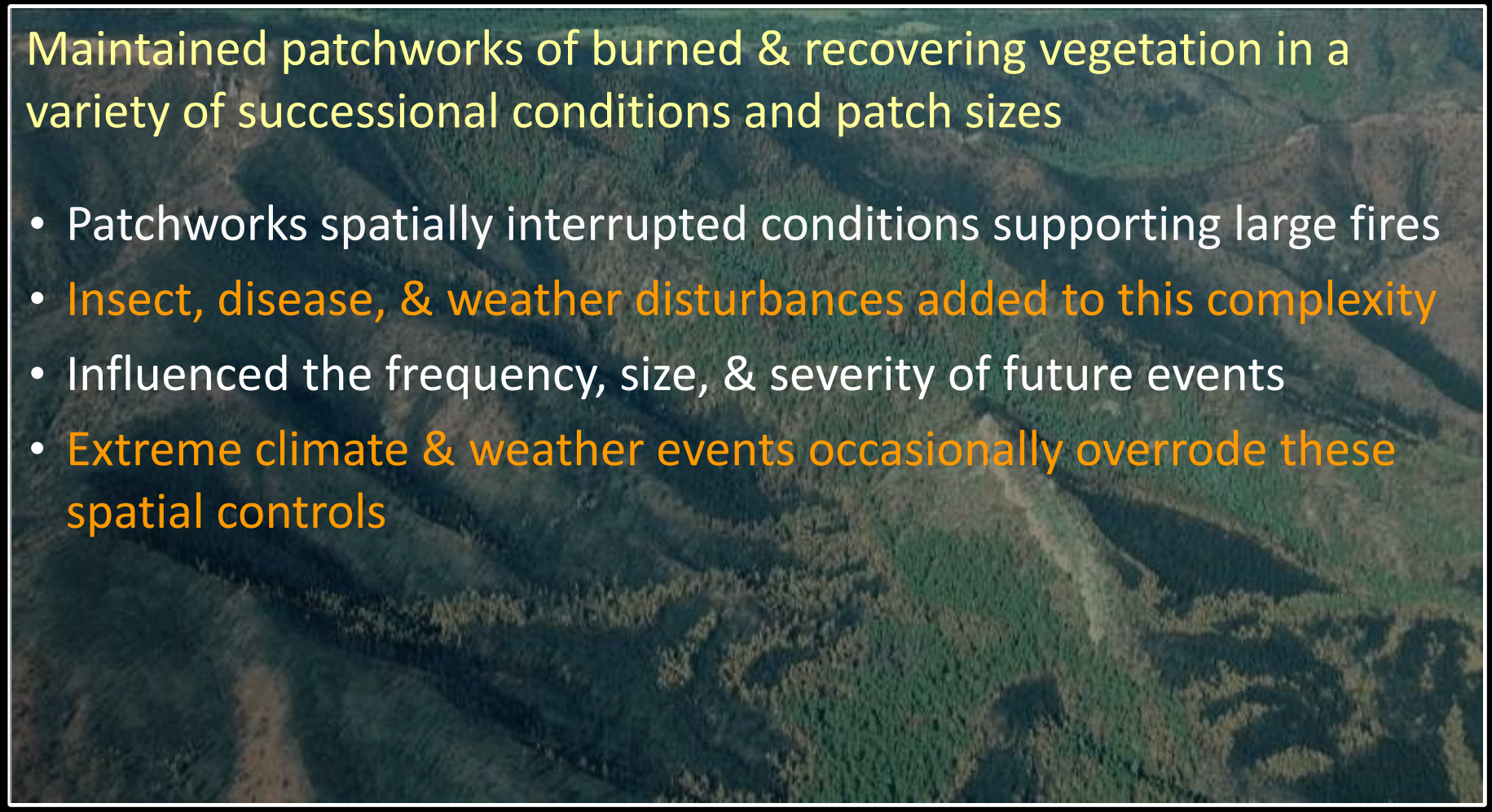
Historical fire regime areas (left). Land cover types (right). Data are from www.landfire.gov.





Peterson, G. D. 2002. Ecosystems 5(4): 329-338.

Historical Wildfire Patterns Provided **Landscape-level Feedbacks** and a Natural Resilience Mechanism…



Maintained patchworks of burned & recovering vegetation in a variety of successional conditions and patch sizes

- Patchworks spatially interrupted conditions supporting large fires
- Insect, disease, & weather disturbances added to this complexity
- Influenced the frequency, size, & severity of future events
- Extreme climate & weather events occasionally overrode these spatial controls

Moritz, Hessburg, & Povak. 2011. Native fire regimes and landscape resilience. In: The Landscape Ecology of Fire: 51-86. Springer.

Patch-scale feedbacks too:

Frequent L & MSFs reinforced resilience by:

- ✓ Reducing surface fuels
- ✓ Increasing the height to live crowns
- ✓ Decreasing crown density
- ✓ Favoring medium and large sized trees
- ✓ Favoring patchy tree and surface fuel cover

Agee J. K. & Skinner C. N. 2005. Forest Ecology and Management 211(1): 83-96.

Time zero

Without fire suppression

+ 40 years


+ 60 years

Feedback of frequent fires:

- Thinning small trees
- Thinning fire-sensitive species
- Consuming surface fuels
- Elevating tree crown bases
- Reducing crown density

With fire suppression

+ 80 years

Change Agents:

Roads and railroads
Subdividing by ownership
Timber harvest – selection and clearcutting
Domestic livestock grazing
Fire prevention/suppression
Urban/rural development
Agriculture

Key Changes:

Fragmented forest – moist forest after HCC
Larger patches – fewer LgT, dry forests, HSR intermediate aged forest dominates
Altered composition – less PP, WL, WWP; more DF, GF, WF, SAF, ES
Increased vulnerability to fires, I&Ds
Fewer grasslands & shrublands, in forest
Fragmented fish networks, fewer fish, barriers
Some roads chronically damaging

East-side Forest Ecosystem Health Assessment, Everett et al. 1994
Interior Columbia Basin (ICBEMP) Assessment, Hann et al. 1997, Quigley et al. 1996, Hessburg et al. 1999, 2000, Lee et al. 1997, Bisson et al. 2003, Rieman et al. 2000, 2010


Lookout Mtn. near Twisp, WA
1930


Lookout Mtn. near Twisp, WA 2011


1934
2010

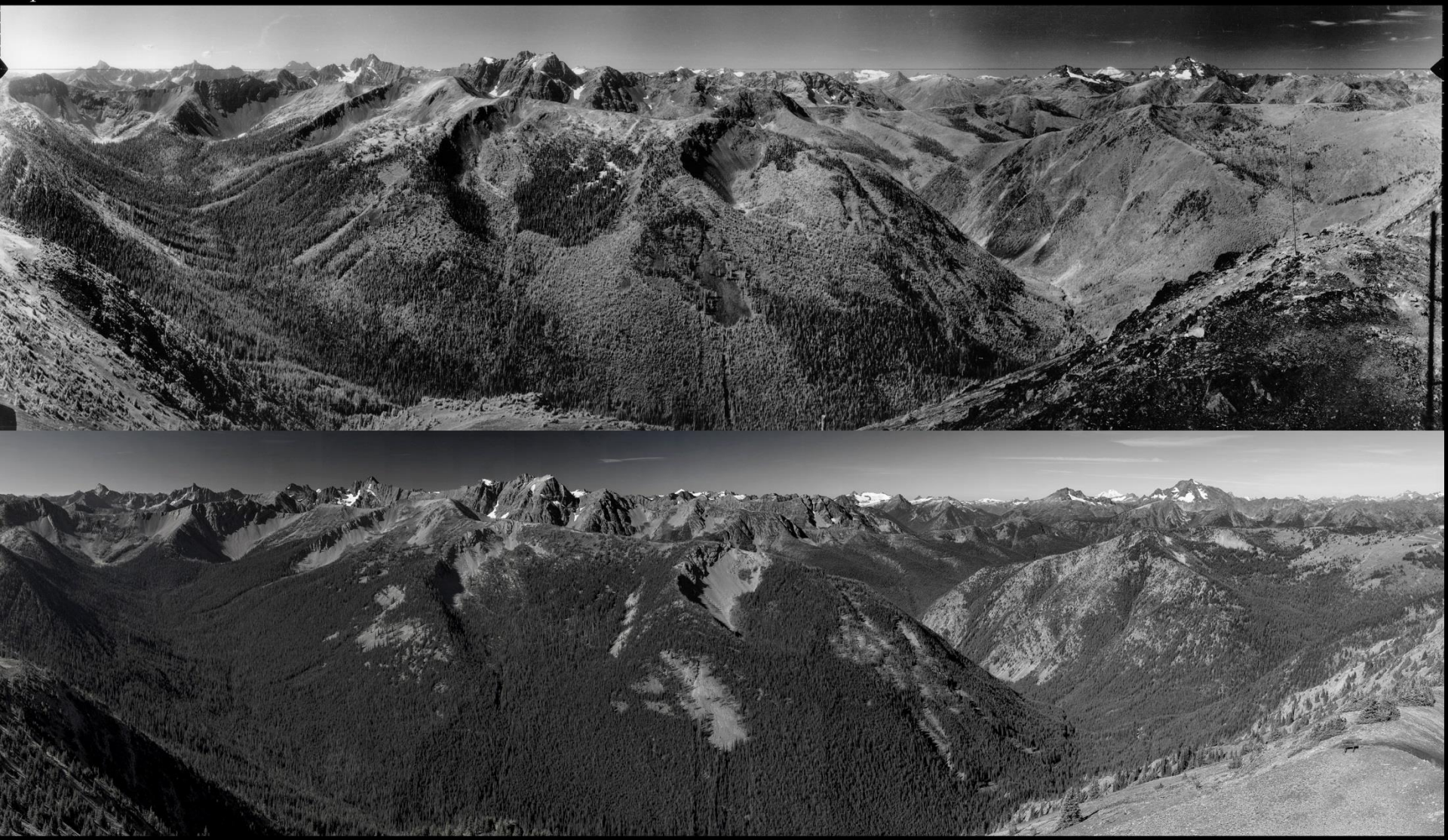

Duncan Hill SE 1934


Duncan Hill SE 2012

Slate Peak

180 degrees
I

300 degrees
I

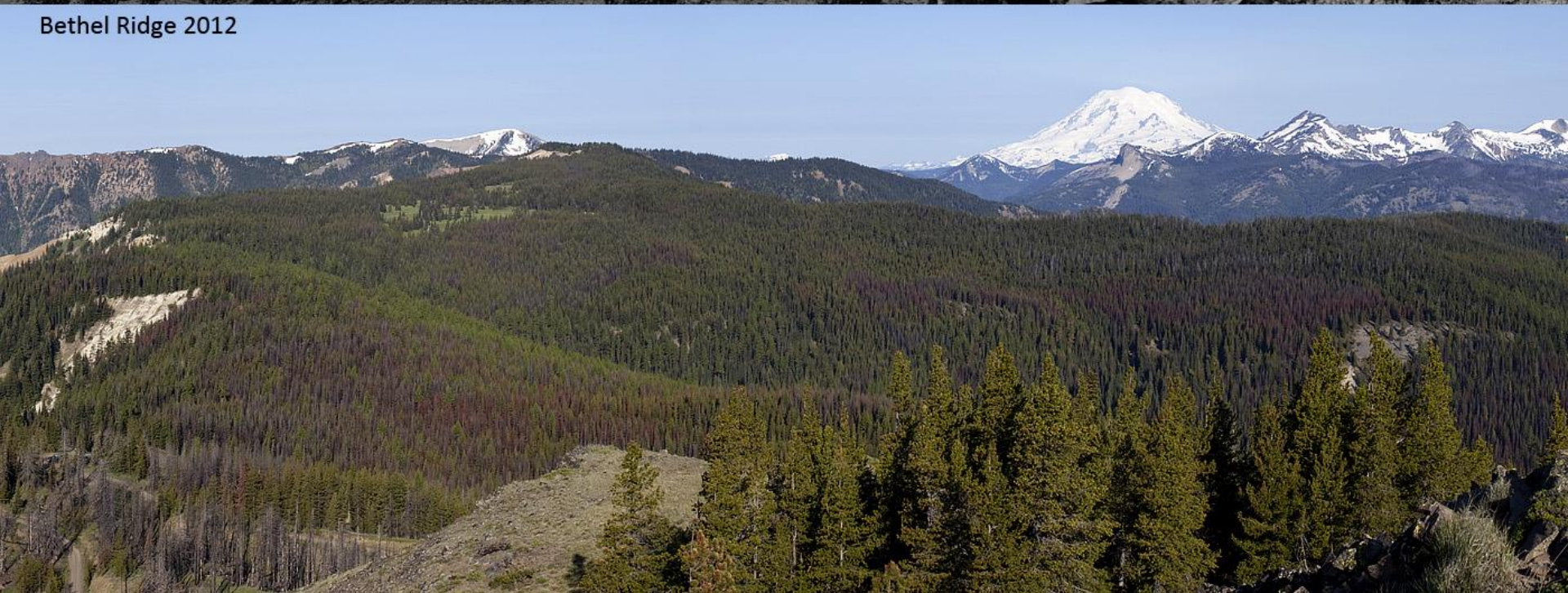


George B. Clisby USFS September 2, 1934
From National Archives and Records Administration, Seattle, WA

16 miles NW of Mazama, WA
Slate Creek drainage

John F Marshall for USFS August 31, 2013

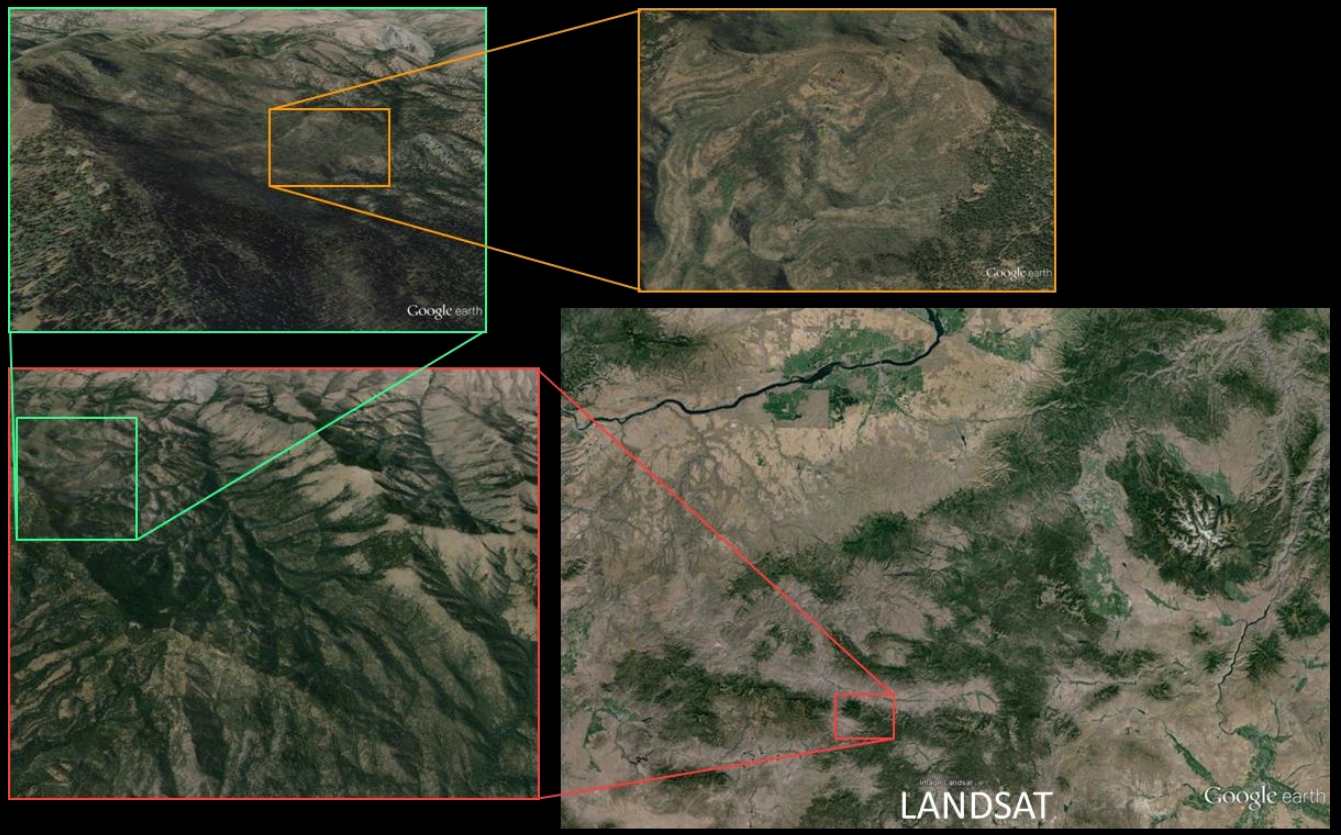

Bethel Ridge 1936


Bethel Ridge 2012

Framing Landscape Restoration: **Core principles**

Regional landscapes function as multi-level, cross-connected, patchwork hierarchies

Conduct planning and management at appropriate scales to effectively restore multi-level landscape patterns, processes, and dynamics

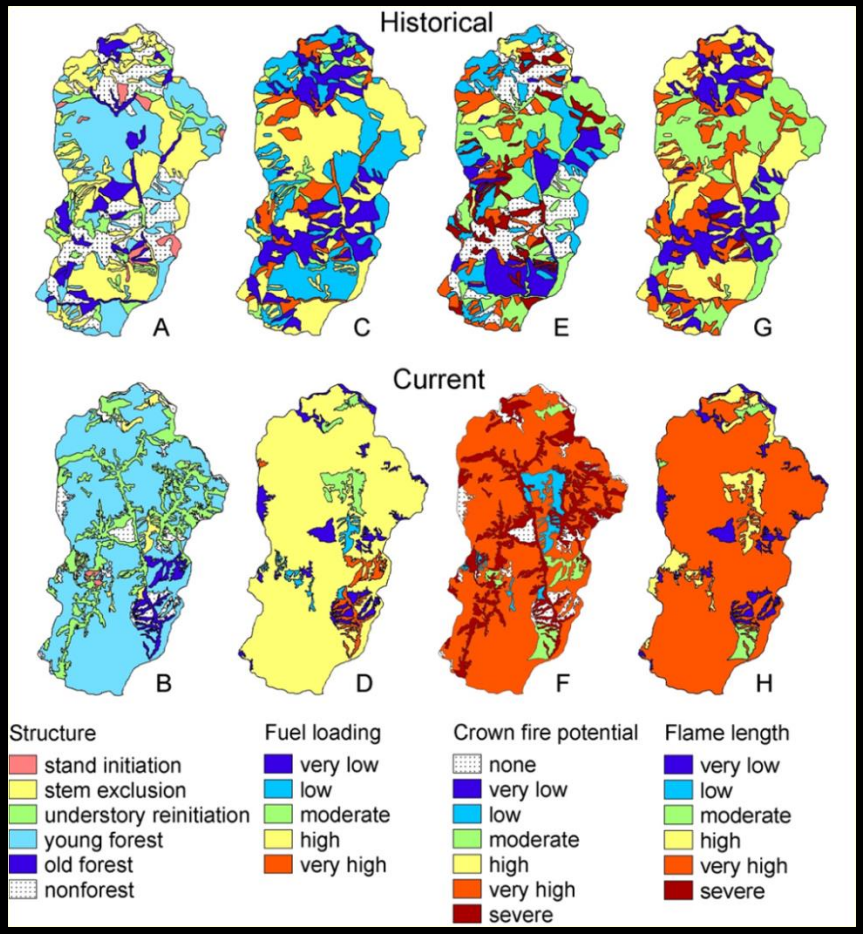


Wu J., & Loucks, O. L. 1995. Quarterly Review of Biology, 439-466
Hessburg et al. 2015. Landscape Ecology (in press).

Framing Landscape Restoration: **Core principles**

Disturbance and succession drive ecosystem change

Restore natural fire regimes and the variation in successional patterns that supported them so that other processes may follow



Keane et al. (2009) For Ecol Manage 258:1025-1037

Bisson et al. (2009) Ecol & Soc 14(1), 45

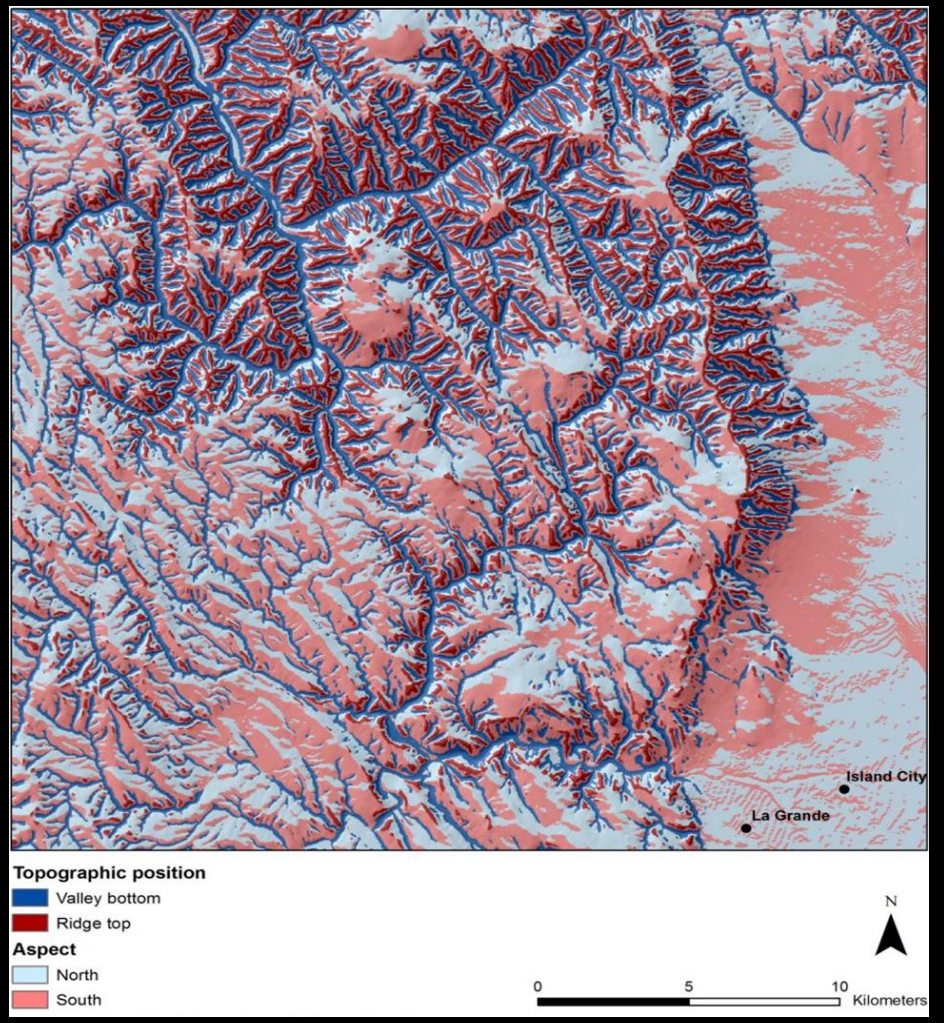
Wiens et al. (2012) Historical environmental variation… 352 p. Wiley-Blackwell

Framing Landscape Restoration: **Core principles**

Topography provides a natural template for vegetation and disturbance patterns at local landscape, successional patch, & tree neighborhood scales

Use topography to guide restoration of successional & habitat patchworks

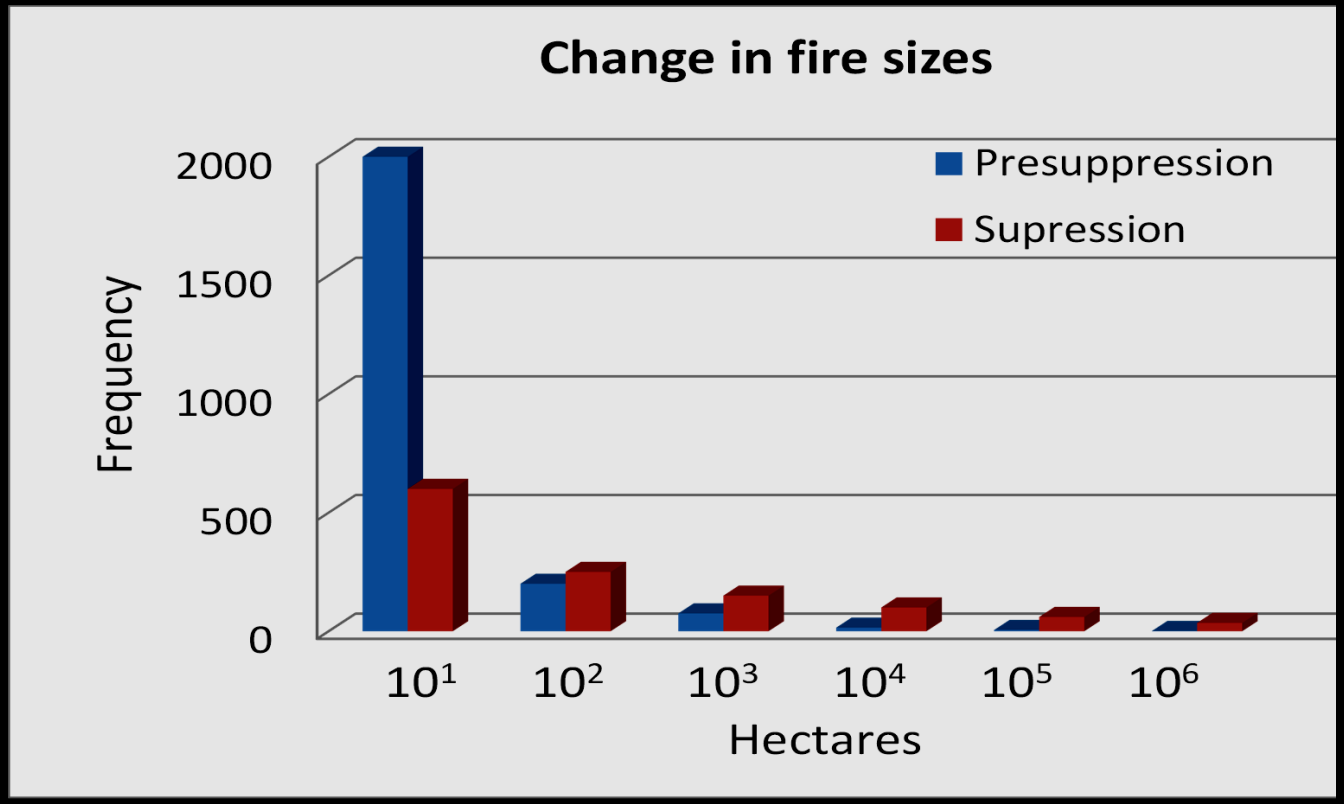
Perry et al. (2011) For Ecol & Mgt 262:703-717
Stine et al. (2014) PNW-GTR-897
Hessburg et al. (2015) Landscape Ecol (in press)



Framing Landscape Restoration: **Core principles**

Predictable patch size distributions historically emerged from linked climate-disturbance-topography-vegetation interactions

Restore size distributions of historical successional patches and allow changing climate and disturbance regimes to adapt them



Moritz et al. 2011. Native fire regimes and landscape resilience. Landscape Ecology of Fire, Springer.
Perry et al. 2011. Forest Ecology and Management 262: 703-717.

Framing Landscape Restoration: **Core principles**

Widely distributed large, old trees provide a critical backbone to dry PP and dry to mesic MC forest landscapes

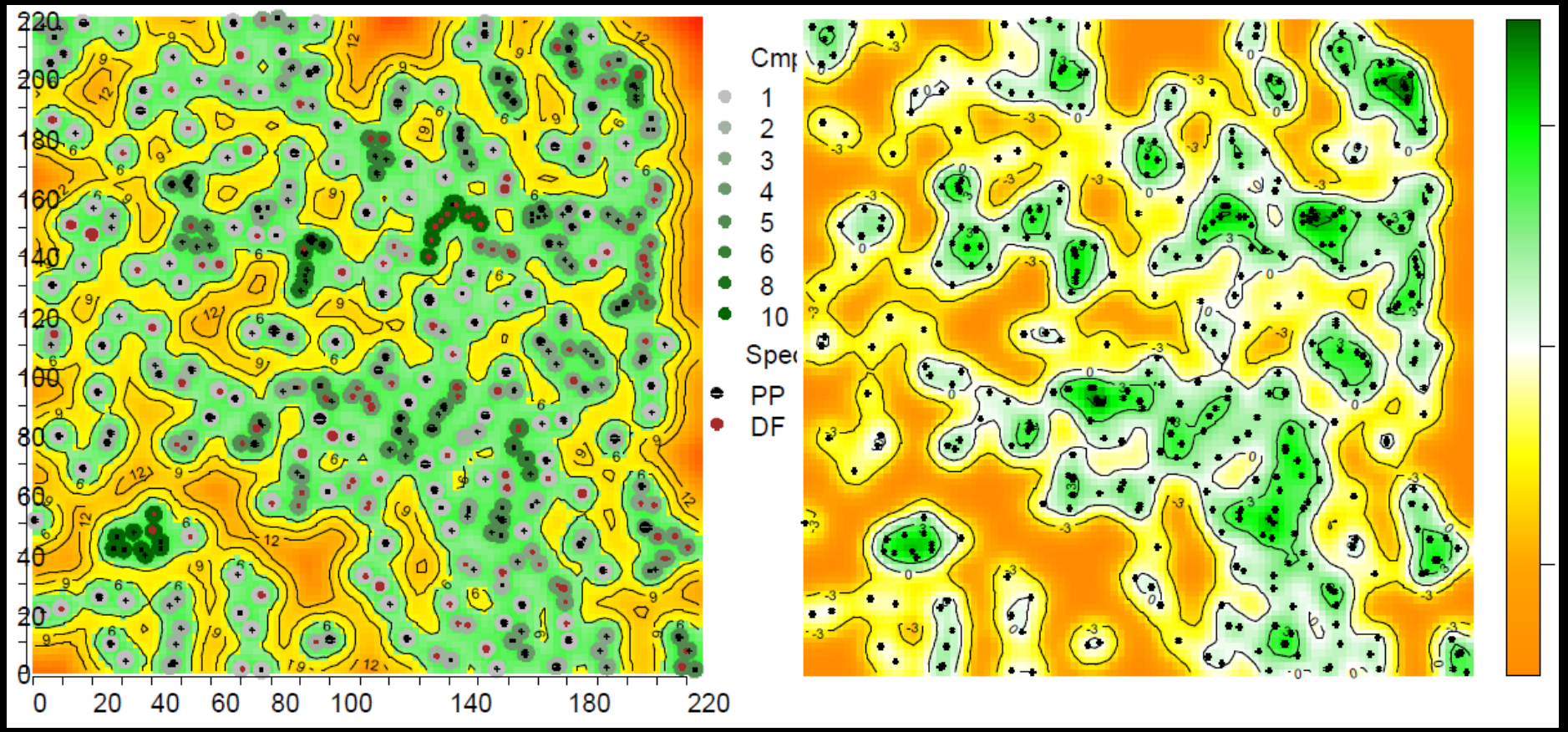
Retain and expand on existing relict trees, old forests, and post-disturbance large snags and down logs in these types

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

Framing Landscape Restoration: **Core principles**

Successional patches are “landscapes within landscapes”

In dry PP, and dry to mesic MC forests, restore characteristic tree clump and gap variation within patches



Larson & Churchill (2012) For Ecol Manage 267:74-92

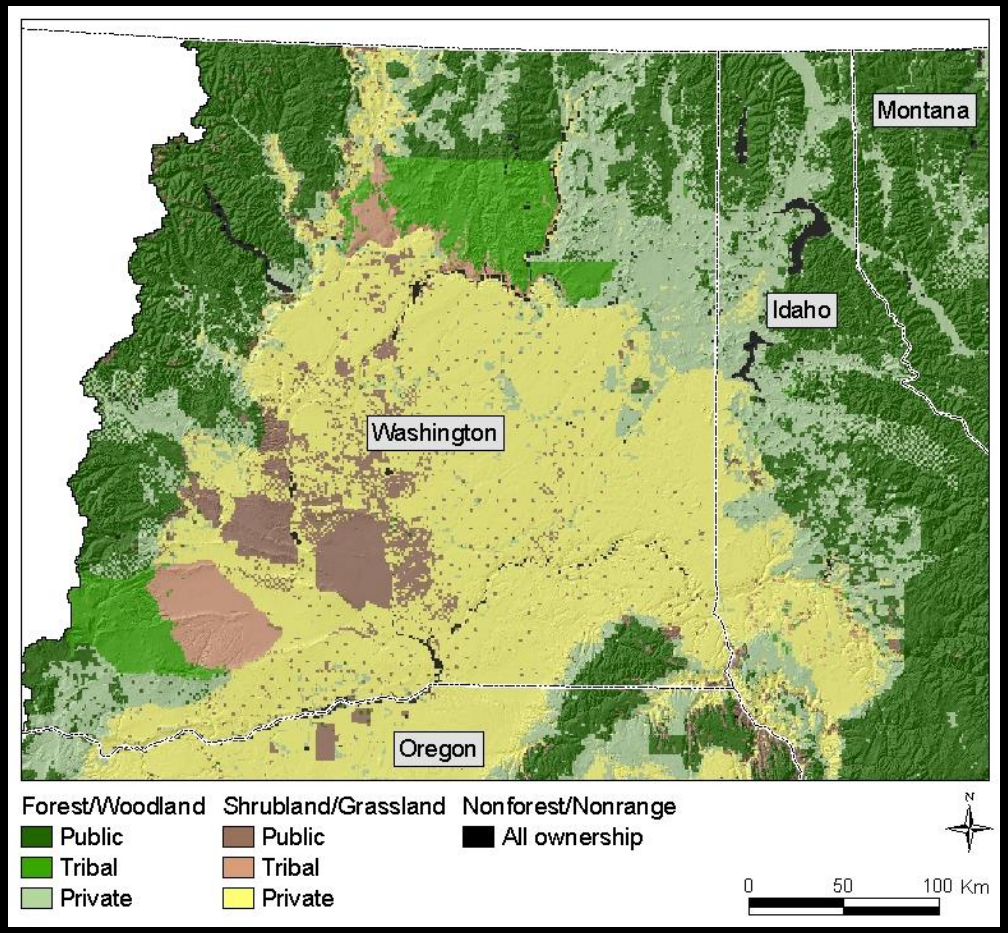
Churchill et al.(2013) For Ecol Manage 291:442-457

Lydersen et al. (2013) For Ecol Manage 304:370-38

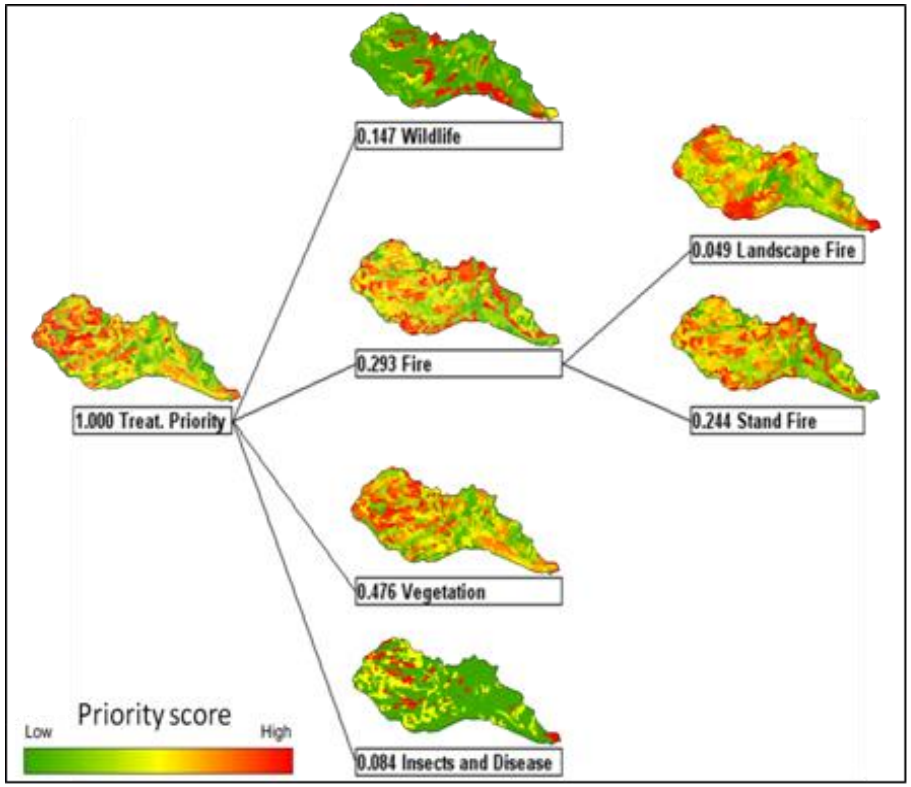
Framing Landscape Restoration: **Core principles**

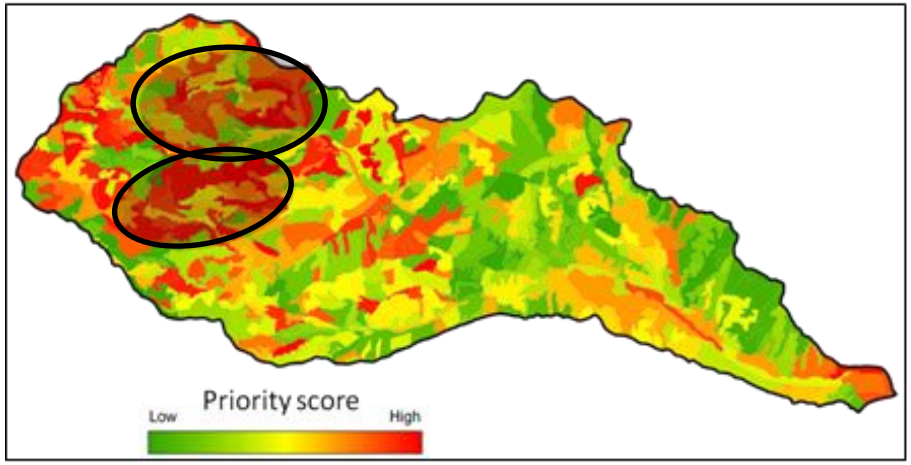
Land ownership, allocation, management and access patterns disrupt landscape and ecosystem patterns

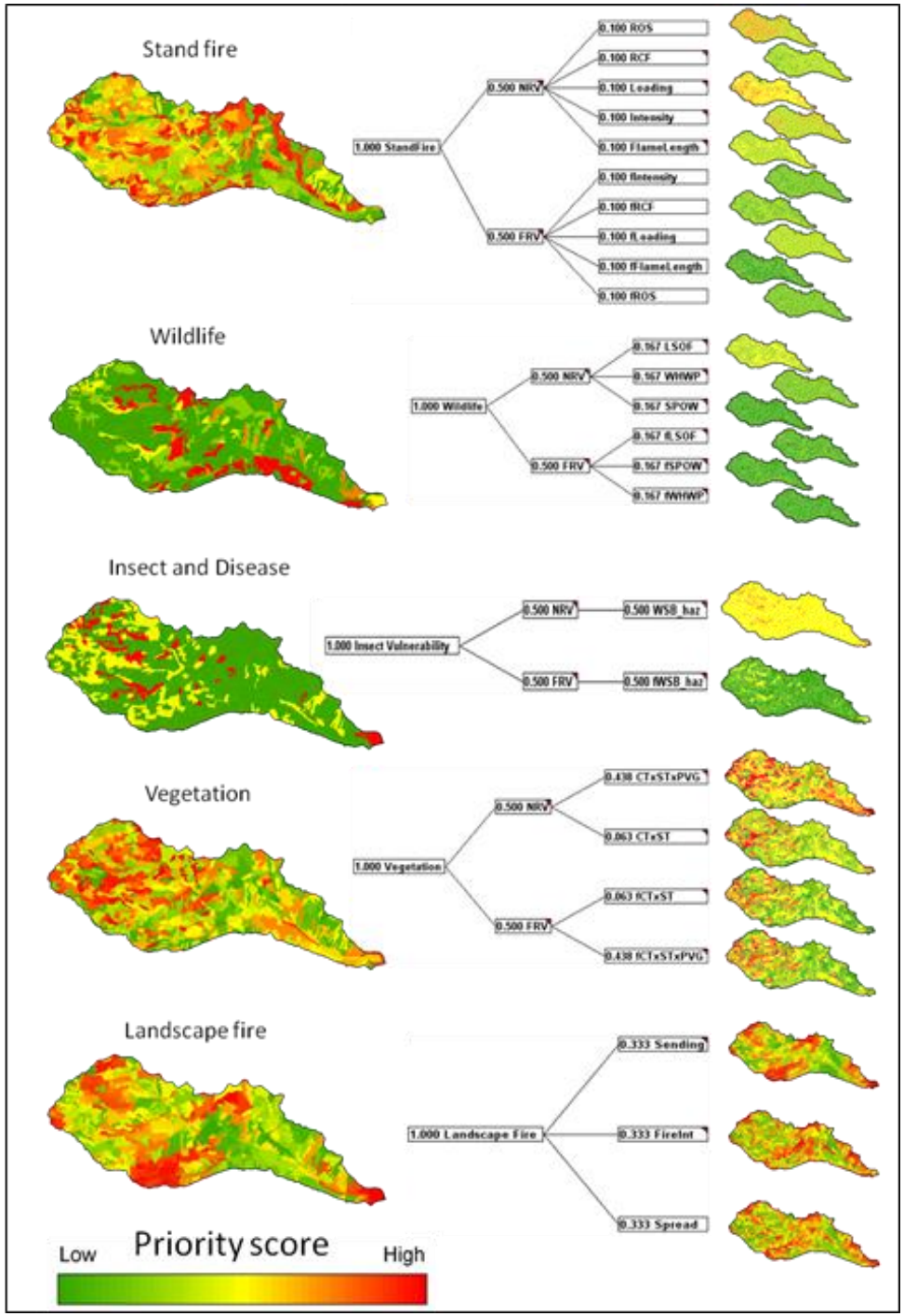
Work collaboratively to develop restoration projects that effectively work across ownerships, allocations, and access needs



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


1.000 Treat. Priority
0.147 Wildlife
0.293 Fire
0.476 Vegetation
0.084 Insects and Disease
0.049 Landscape Fire
0.244 Stand Fire
Priority score
Low
High


Priority score
Low
High


Stand fire
1.000 Standfire
0.500 NRV
0.500 FRV
0.100 ROS
0.100 RCF
0.100 Loading
0.100 Intensity
0.100 FlameLength
0.100 fIntensity
0.100 fRCF
0.100 fLoading
0.100 fFlameLength
0.100 fROS
Wildlife
1.000 Wildlife
0.500 NRV
0.500 FRV
0.167 LSOF
0.167 WHWP
0.167 SPOW
0.167 fLSOF
0.167 fSPOW
0.167 fWHWP
Insect and Disease
1.000 Insect Vulnerability
0.500 NRV
0.500 FRV
0.500 WSB_haz
0.500 fWSB_haz
Vegetation
1.000 Vegetation
0.500 NRV
0.500 FRV
0.438 CTxSTxPVG
0.063 CTxST
0.063 fCTxST
0.438 fCTxSTxPVG
Landscape fire
1.000 Landscape Fire
0.333 Sending
0.333 FireInt
0.333 Spread
Low
Priority score
High

Wildfire and Native Fish:

Restoring Terrestrial & Aquatic Ecosystems

- Are they separate, or one connected system?
- Is there just conflict?
- Or is there opportunity for convergent solutions?

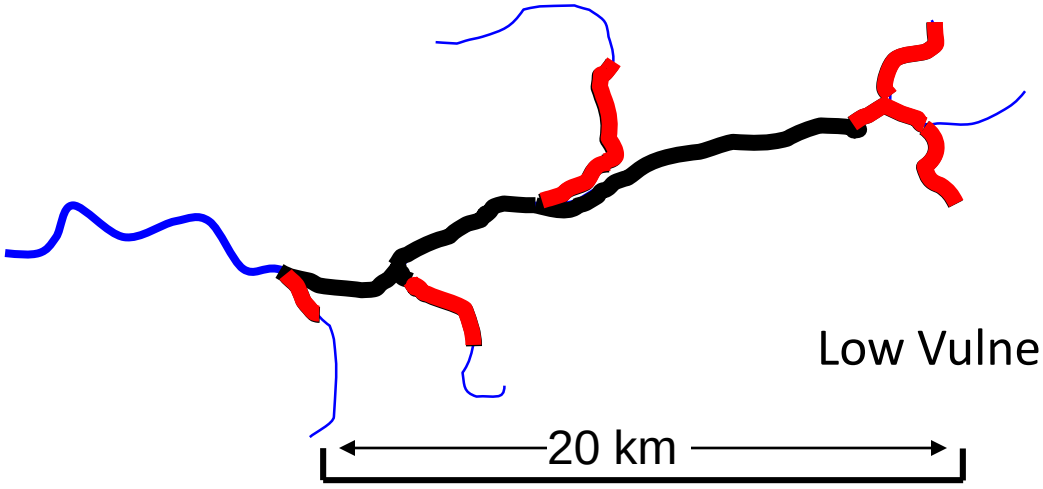
Managing Forests and Fish

Characteristic fire regimes…

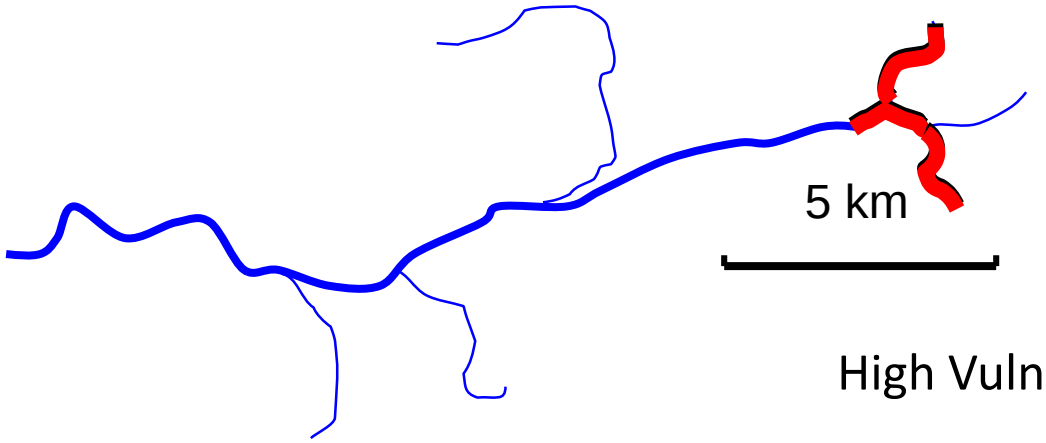
- Limit extent of severe disturbance
- Provide the pulsed rhythm of essential, habitat forming physical processes
- Zone the frequency & variable severity of pulsed disturbances
- …which are critical to fish persistence
- …and which drive terrestrial and aquatic habitat succession

Context Matters

Scaling is key….



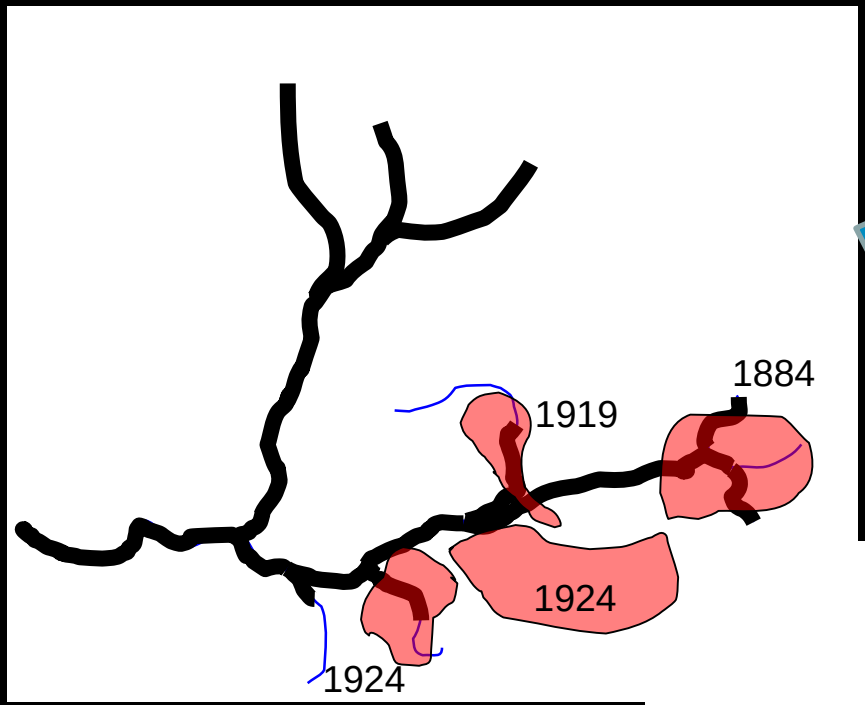
Low Vulnerability

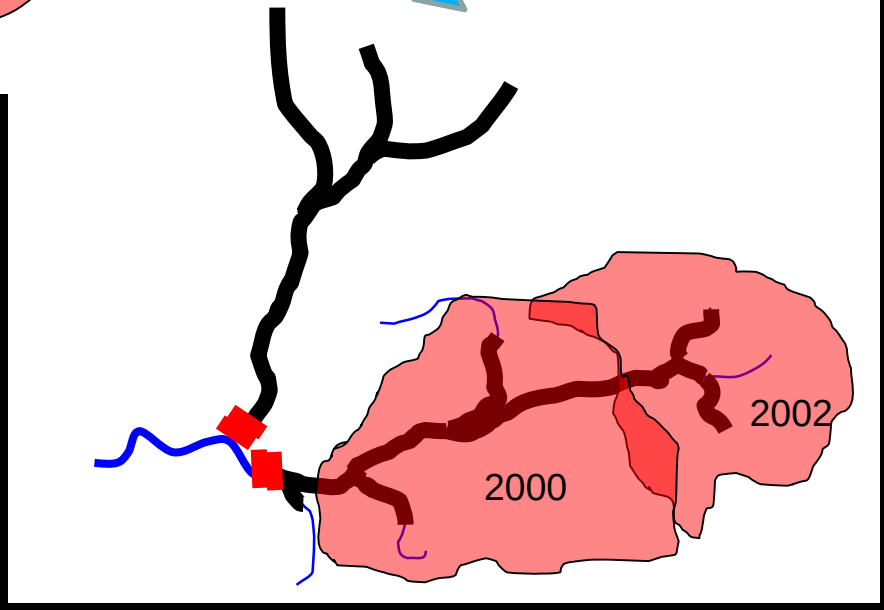


High Vulnerability

Context Matters

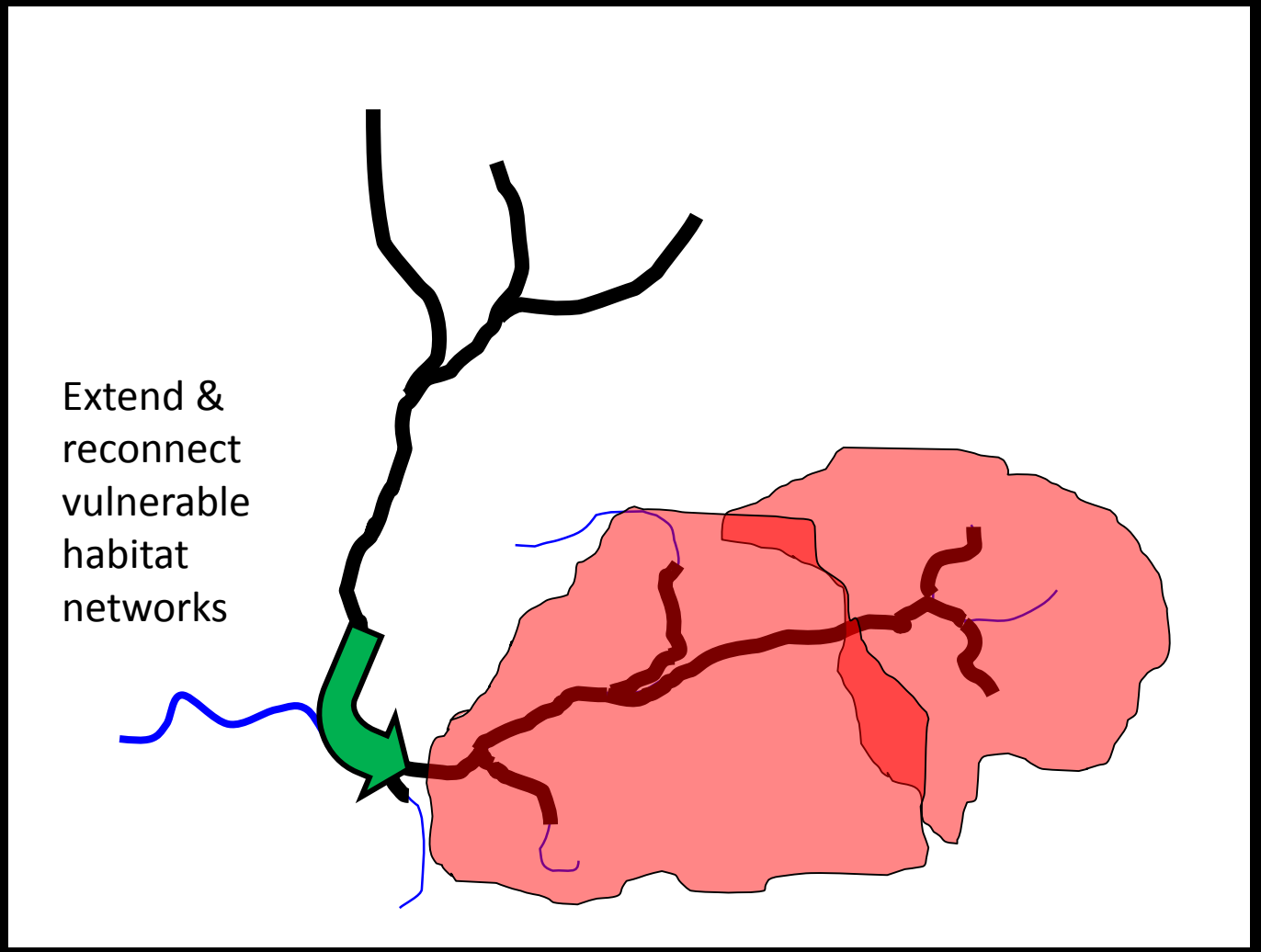
Scaling and management…





Context Matters

Scaling and management…

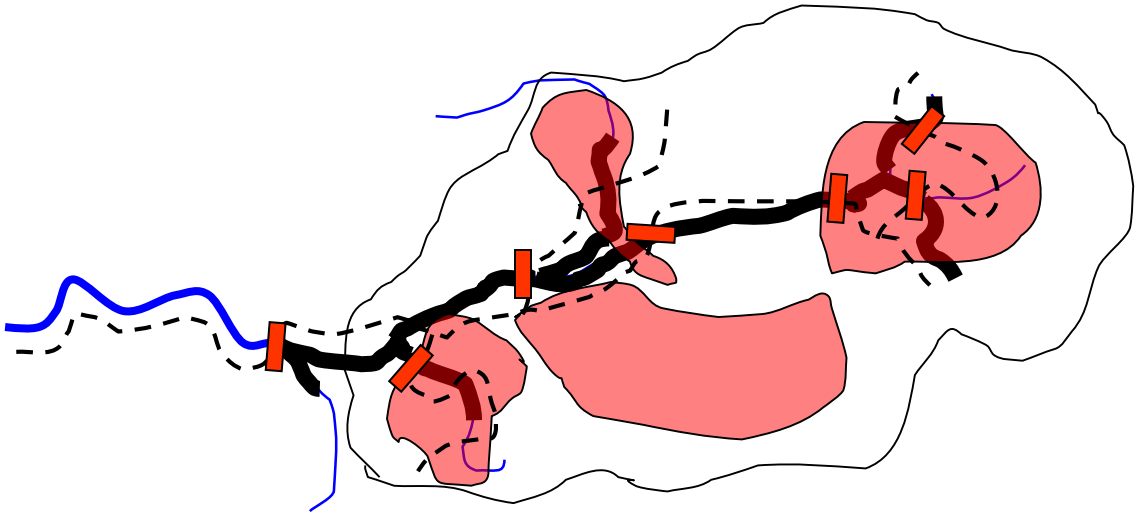


Context Matters

Scaling and management…

Re-establish scale and pulsed rhythm of disturbances

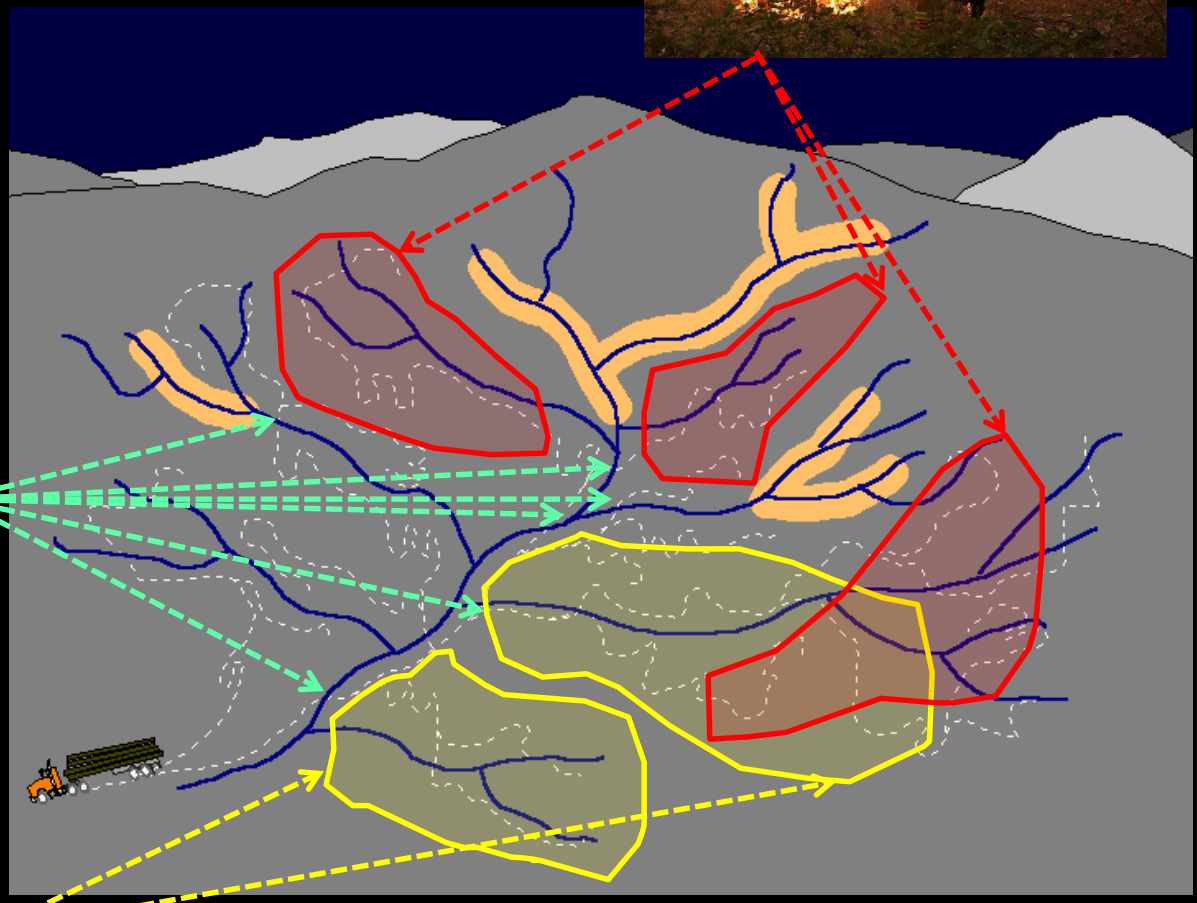
…but can we do it w/o aggravating existing problems?



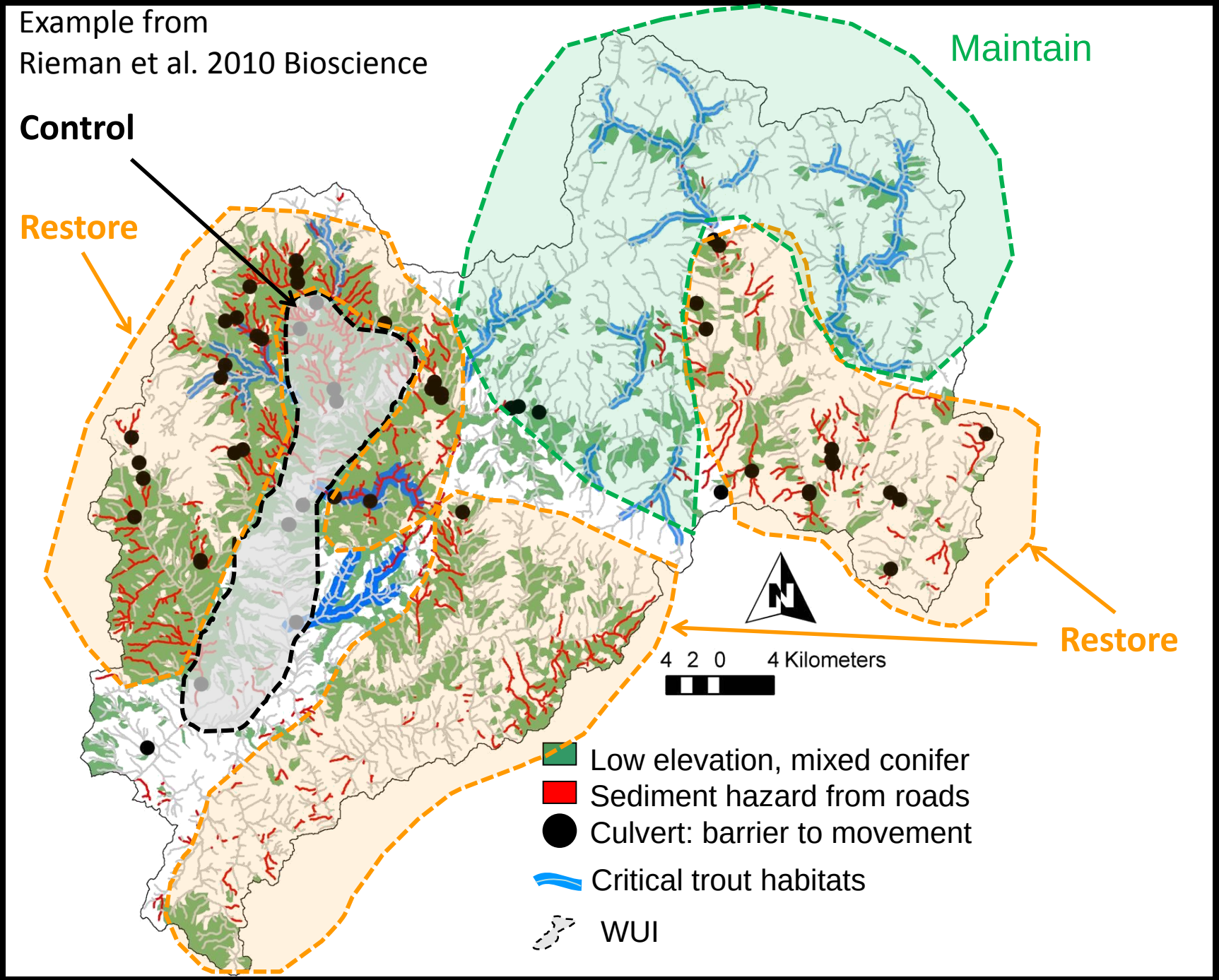
Clarity in goals and objectives

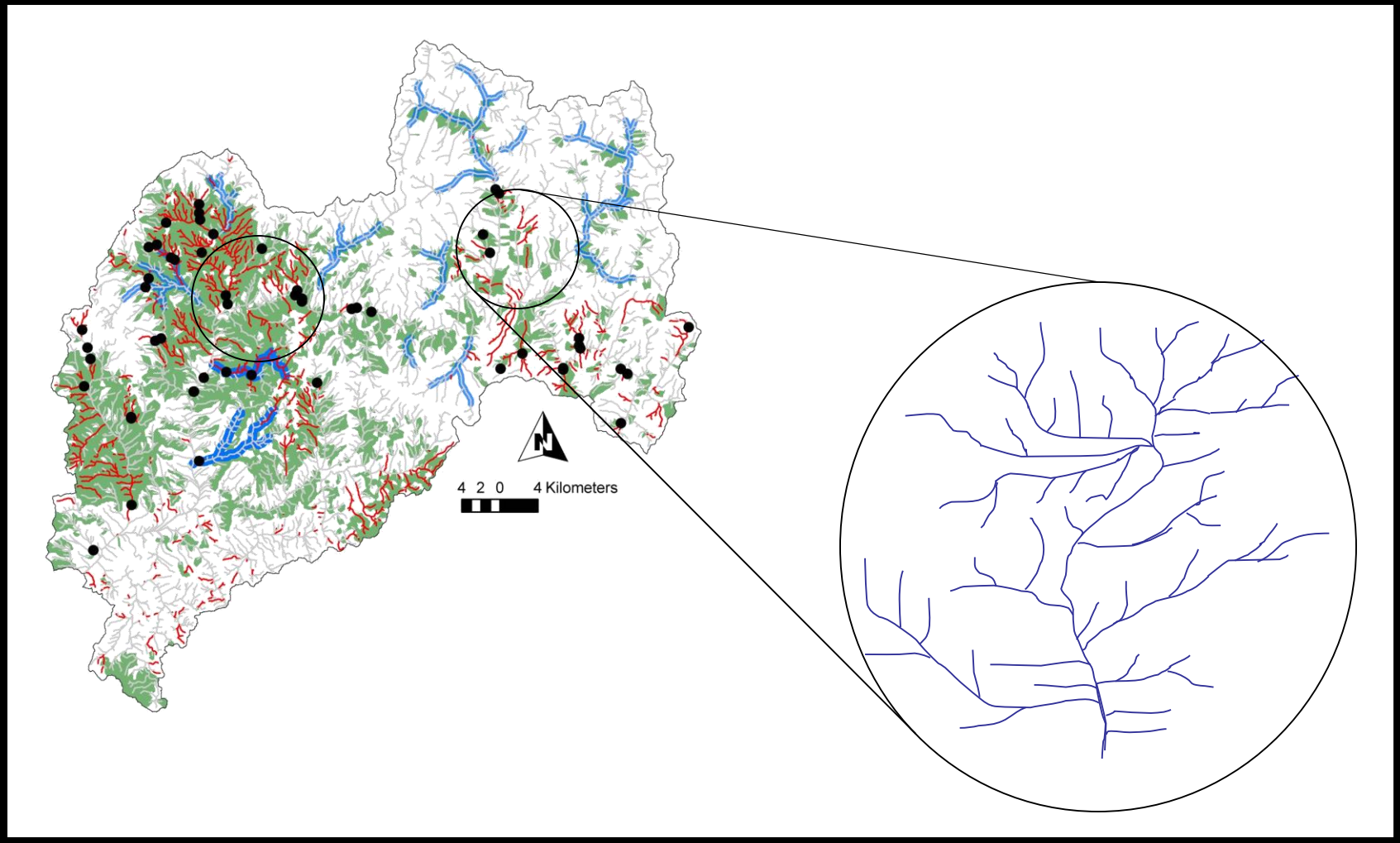
Rieman et al. 2000. Env. Mgt. 25(4): 425-444

Rieman et al. 2010. BioScience 60(6): 460-468



There are important opportunities
for simultaneous solutions…..

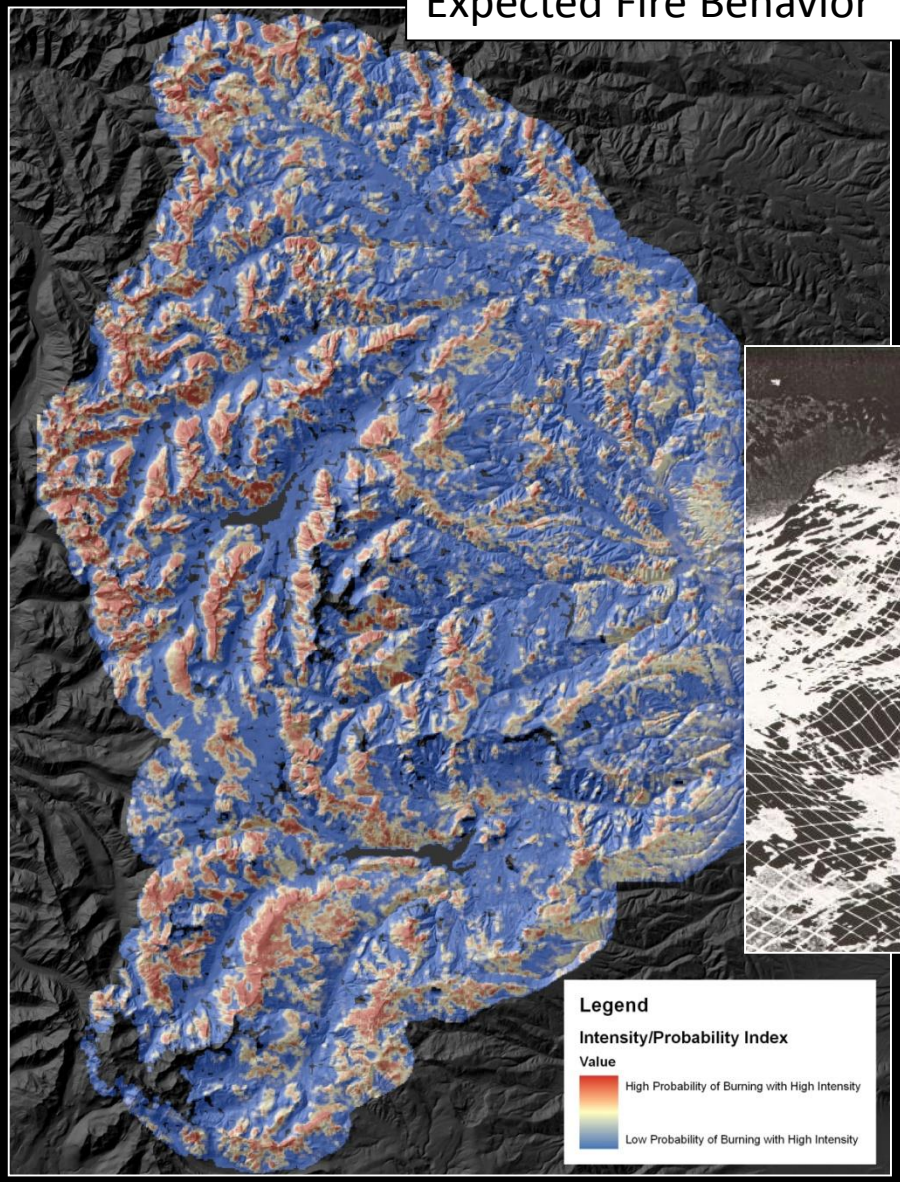

Example from
Rieman et al. 2010 Bioscience
Control
Restore
Maintain
Restore
N
4 2 0 4 Kilometers
Low elevation, mixed conifer
Sediment hazard from roads
Culvert: barrier to movement
Critical trout habitats
WUI



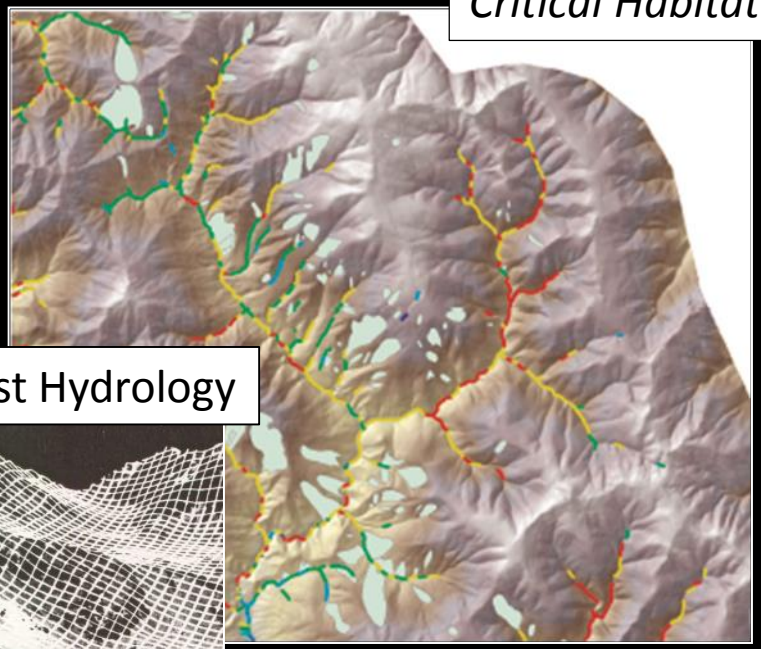
Focus high resolution analysis where it is really needed

Rapidly expanding analytical capacity

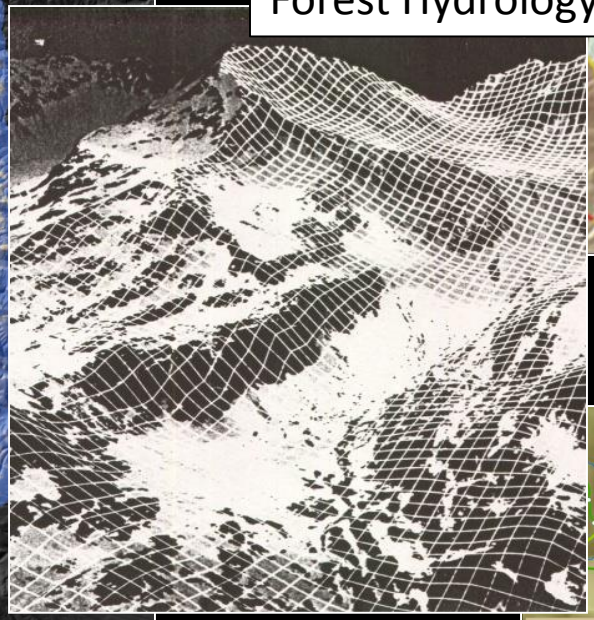
Expected Fire Behavior



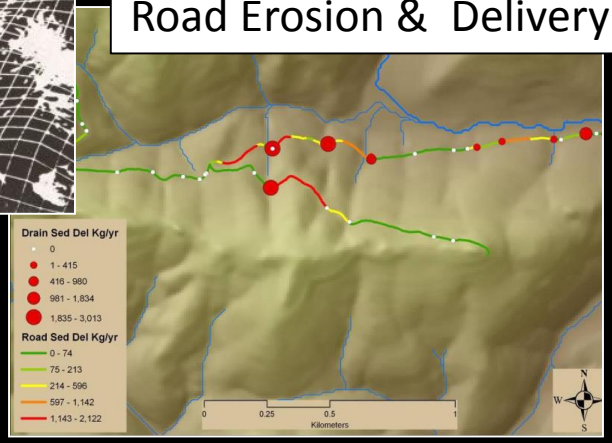
Critical Habitat



Forest Hydrology



Road Erosion & Delivery



Summary

- One linked terr/aqu system
- Linkage via multi-scale patterns & processes
- High functioning wildfire regimes are key to aqu habitat succession
- Hanging on to terr/aqu system mgt conflicts is limiting
- Opportunity for convergent solutions, let's explore them
- Fish habitat restoration partially depends on high-functioning fire regimes; i.e., fish are fire dependent spp.
- Restoring fire regimes is one important aspect of recovering listed anadromous and cold water fish

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Acknowledgments

Bruce Rieman (slides, ideas)

Andrew Larson (slides)

Gordie Reeves (discussions)

John Marshall (photos)

Brion Salter (maps)