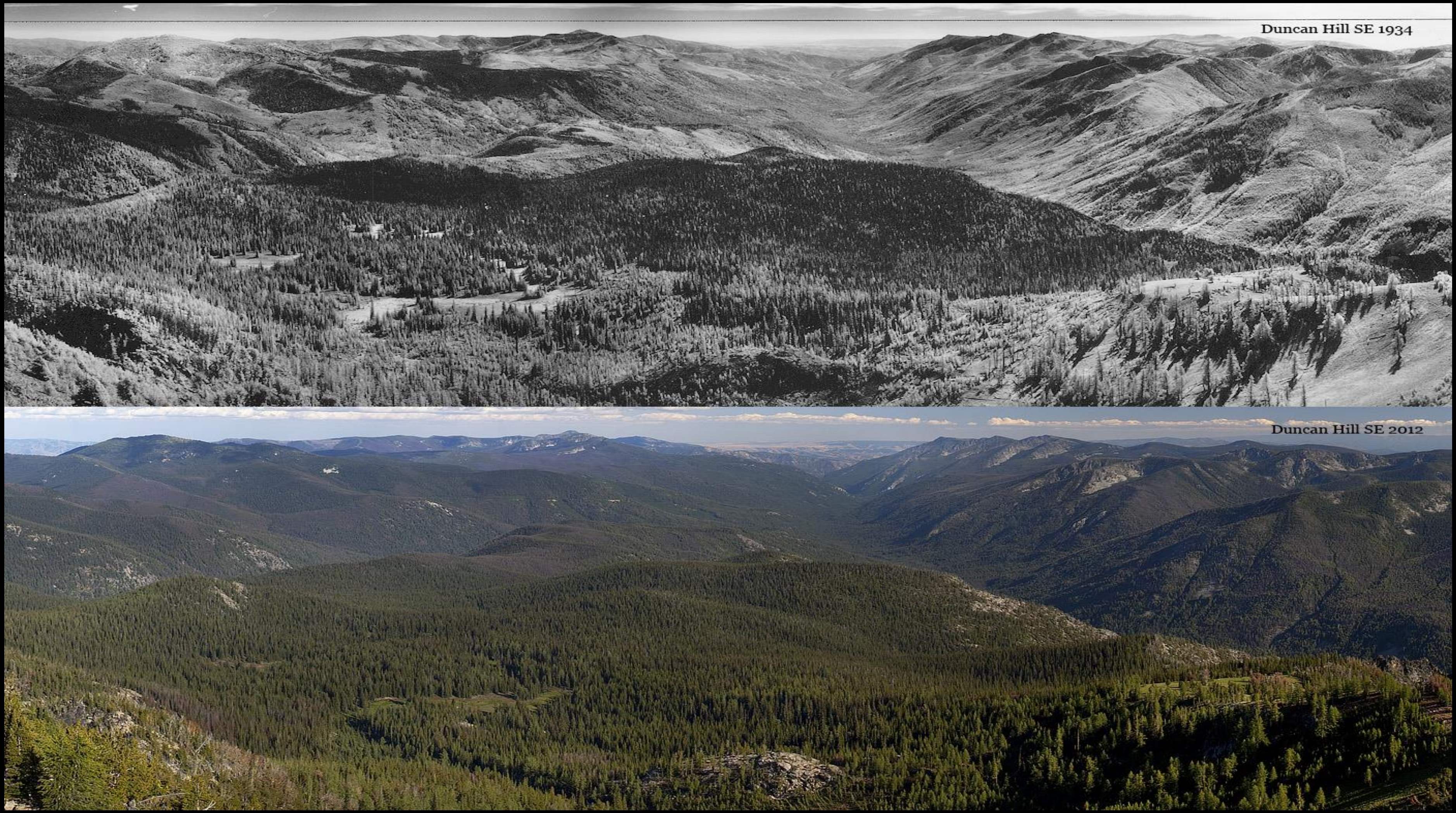
The Changing Landscape and Fire Ecology of Interior BC Forests

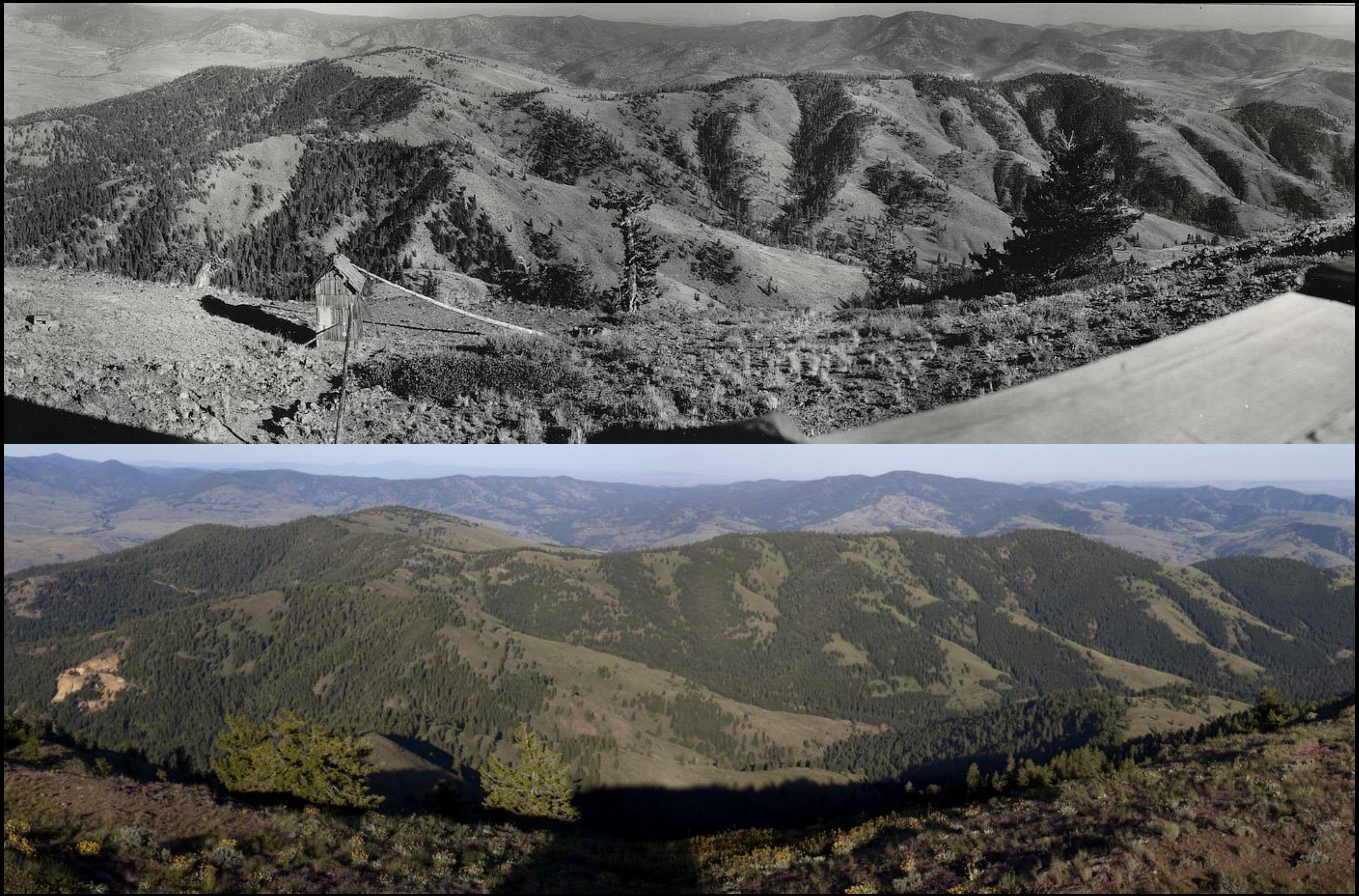


Paul Hessburg, USDA-FS, PNW Research Station, OSU & UW

Interior BC:

A region of great biotic, cultural, & environmental diversity

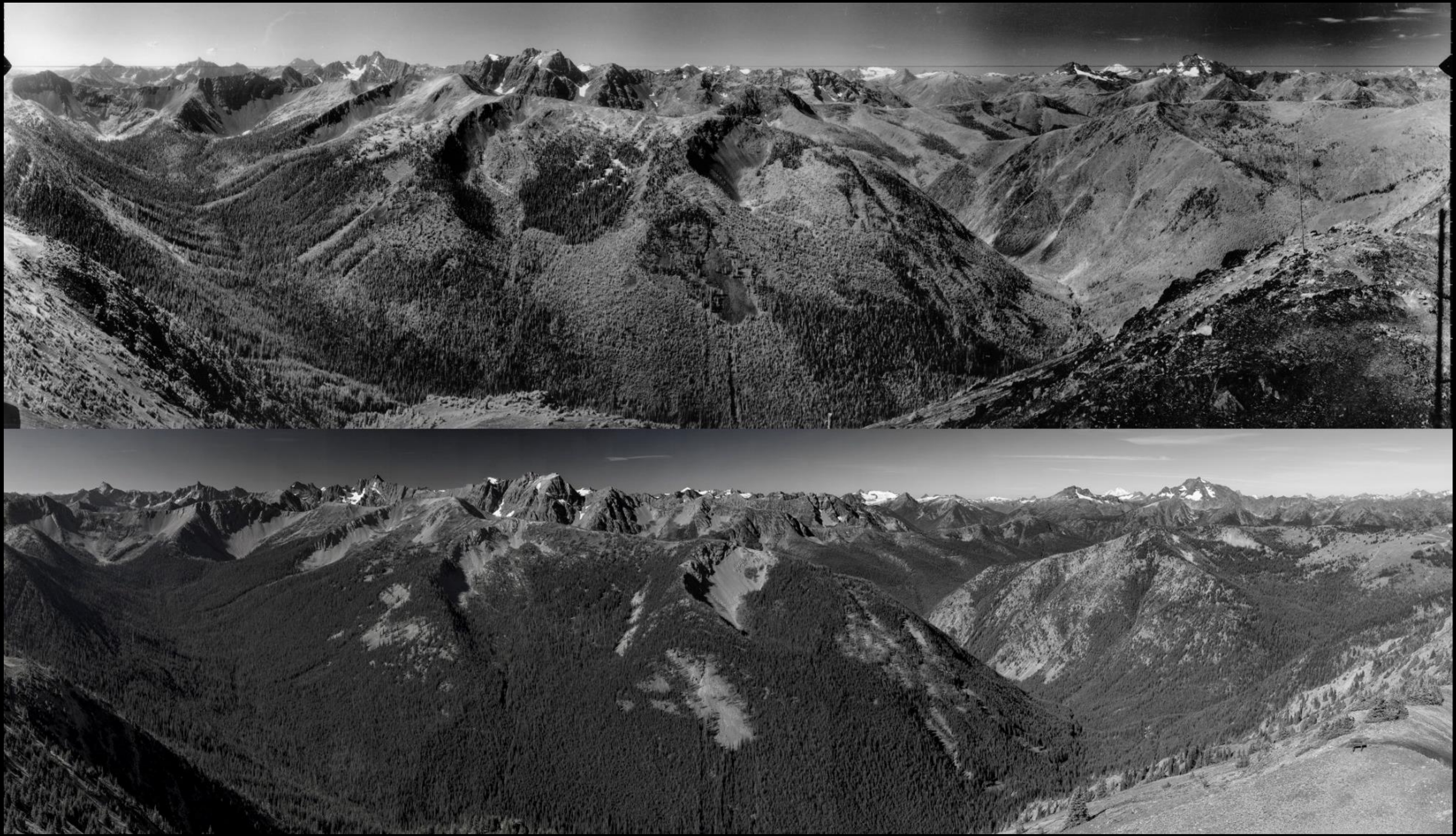
…but it is greatly changed over the last 150 yrs



Dry forests have encroached on once extensive grasslands & meadows

Dry south slopes and ridgetops have filled in with trees

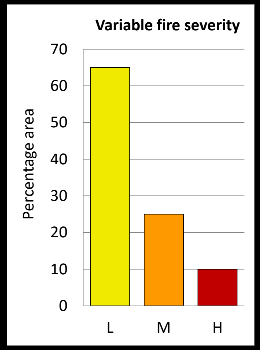
Complex patchworks of non-forest, early, mid, and later-seral forests became dense, layered forests



And most importantly, patchworks of burned and recovering forest gave way to contiguous forest, in all forest types

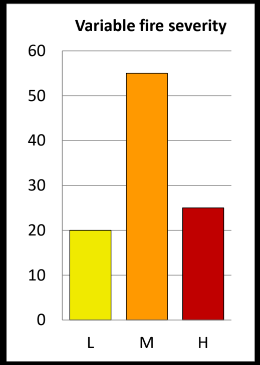
Change Agents:		Key Changes:
Roads and railroads	>>	Created a vast fuelbreak network
Subdividing by ownership	>>	Fragmented forests by varied management plans
Clearcutting	>>	Cut older forests; Removed LgPP, DF, WL; left small
Selection cutting	>>	DF, GF, SAF, LPP; increased vulnerability to fire, I&Ds
Domestic livestock grazing	>>	Livestock ate the grasses, excluding frequent fires
Fire suppression	>>	Widely increased forest area and density
Urban/rural development	>>	Excluded fires, promoted aggressive fire suppression
Agriculture	>>	Eliminated grasslands/shrublands, excluded fires
Climate change	>>	Larger and more severe fires

Historical



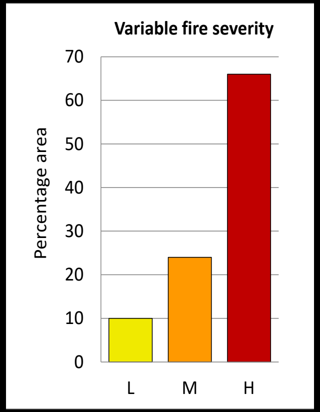
⇩

Current



- ✓ Low severity fire (LSF): <20% of the tree cover killed, common in dry forests
- ✓ Fires every 5-25 yrs, reducing surface fuels, thinning trees
- ✓ High-frequency reinforced low severity
- ✓ More extreme climate conditions, more severe fires

Historical



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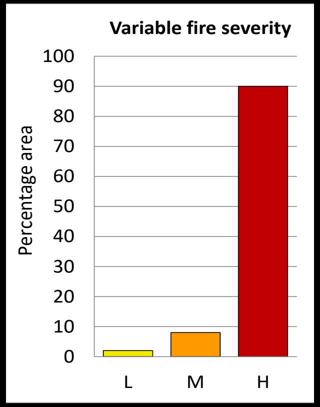
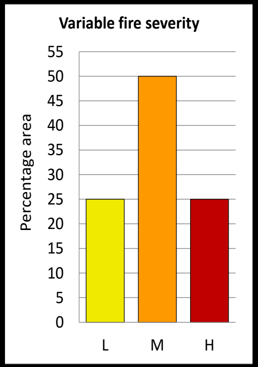
Current

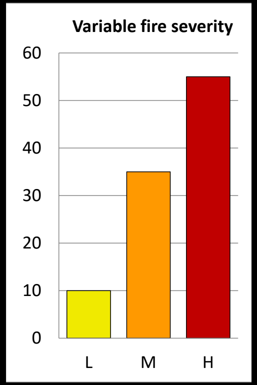


- ✓ High severity fire (HSF): >70% of the tree cover killed
- ✓ Common in moist & cold forests where fires occurred every 150-300+ yr
- ✓ Mild climate/weather conditions favored milder fires
- ✓ Created variation in fire severity & fire event patch size distributions

Historical



Current



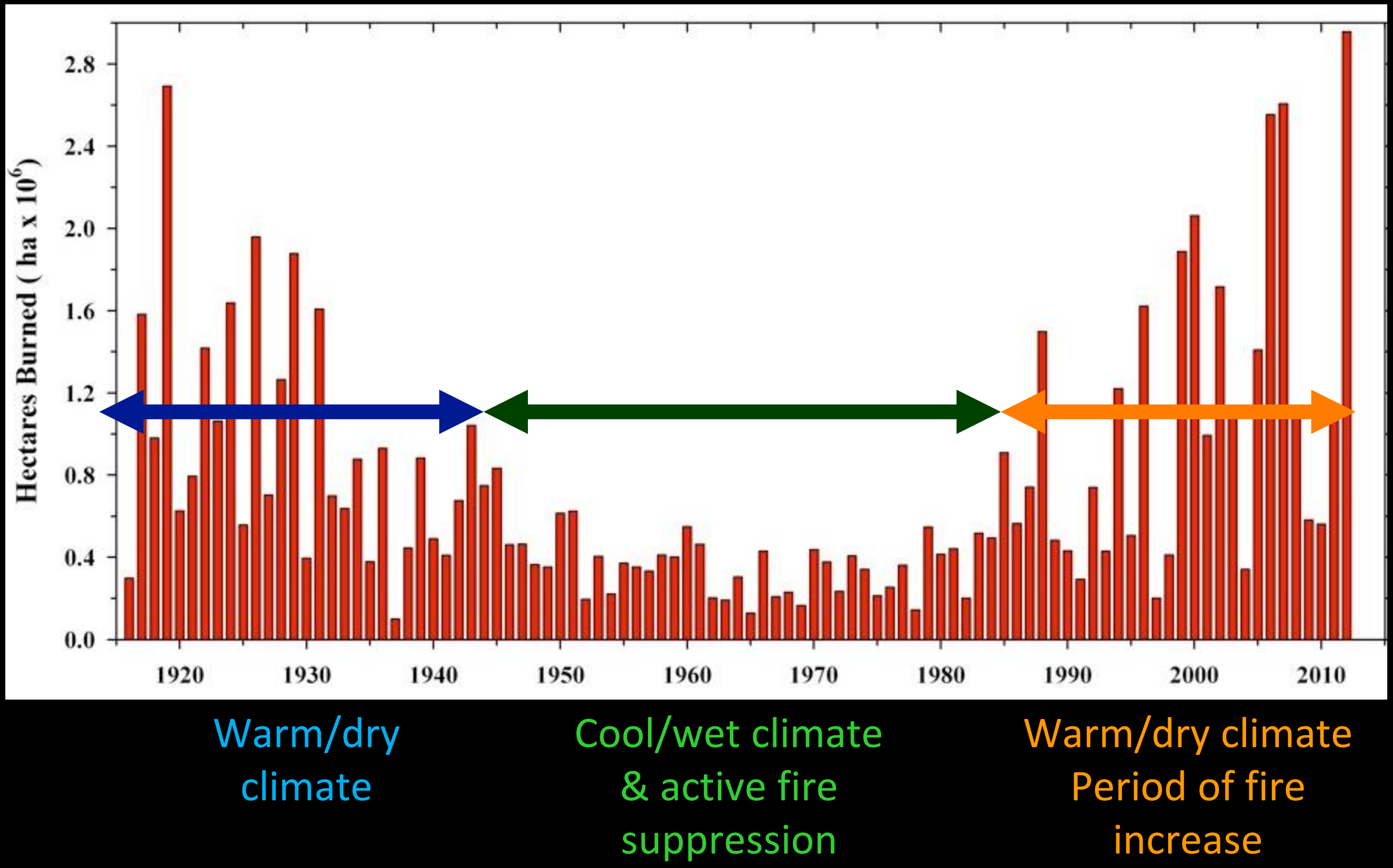
- ✓ Mixed severity fire (MSF): 20-70% of the tree cover killed
- ✓ Common in DMC & MMC forests w/ PP, DF, GF, WL
- ✓ Fires occurred every 30-50+ yrs, both surface and crown fire effects
- ✓ Occasionally both milder & more severe fires occurred, weather/climate driven

Important feedbacks

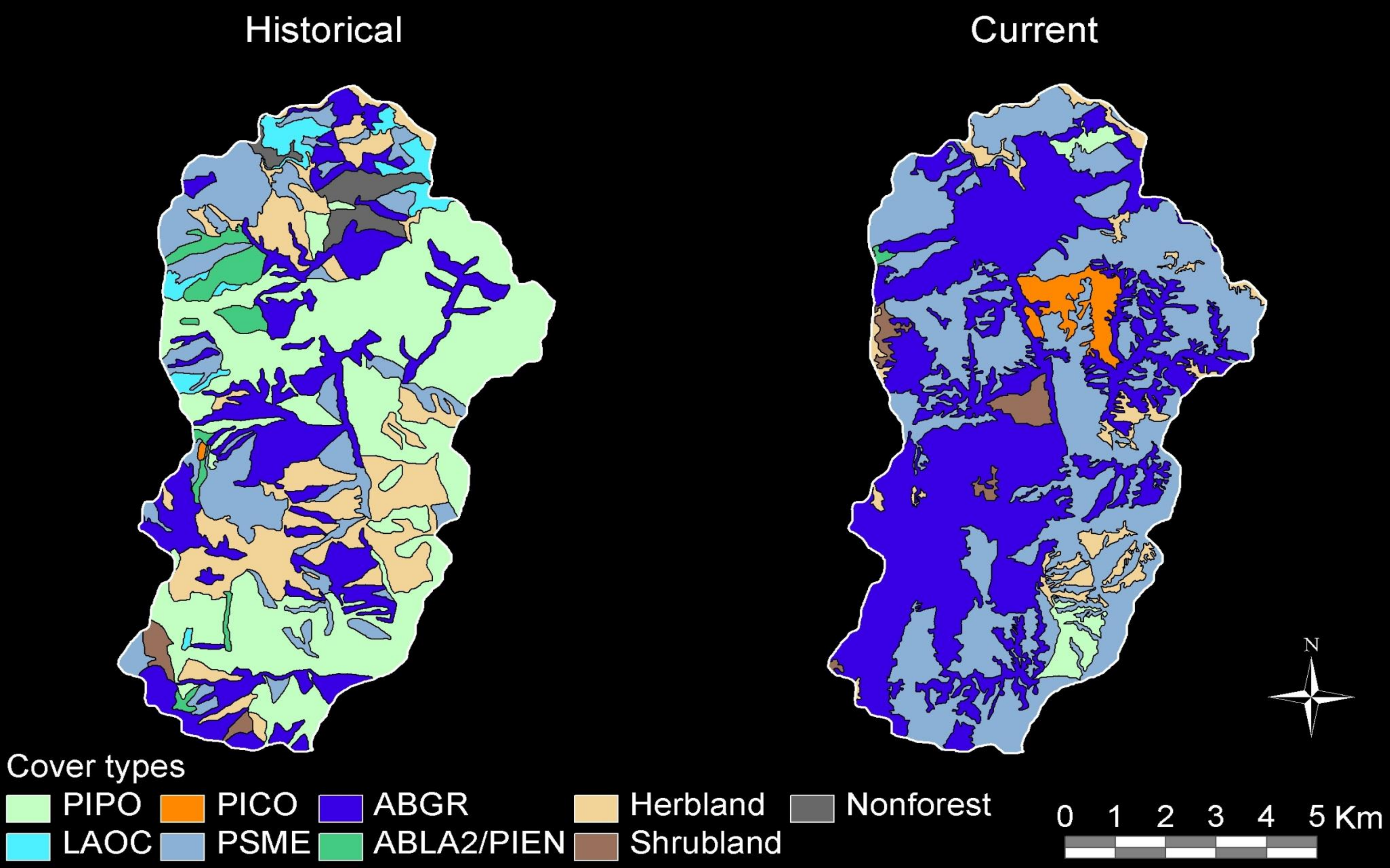
1) Locally—LSFs & MSFs continually thinned forest patches, reducing tree density and fuels

2) Regionally—fires created variable patchworks of nonforest, early, mid, late seral conditions, these patterns spatially controlled future fire size & severity

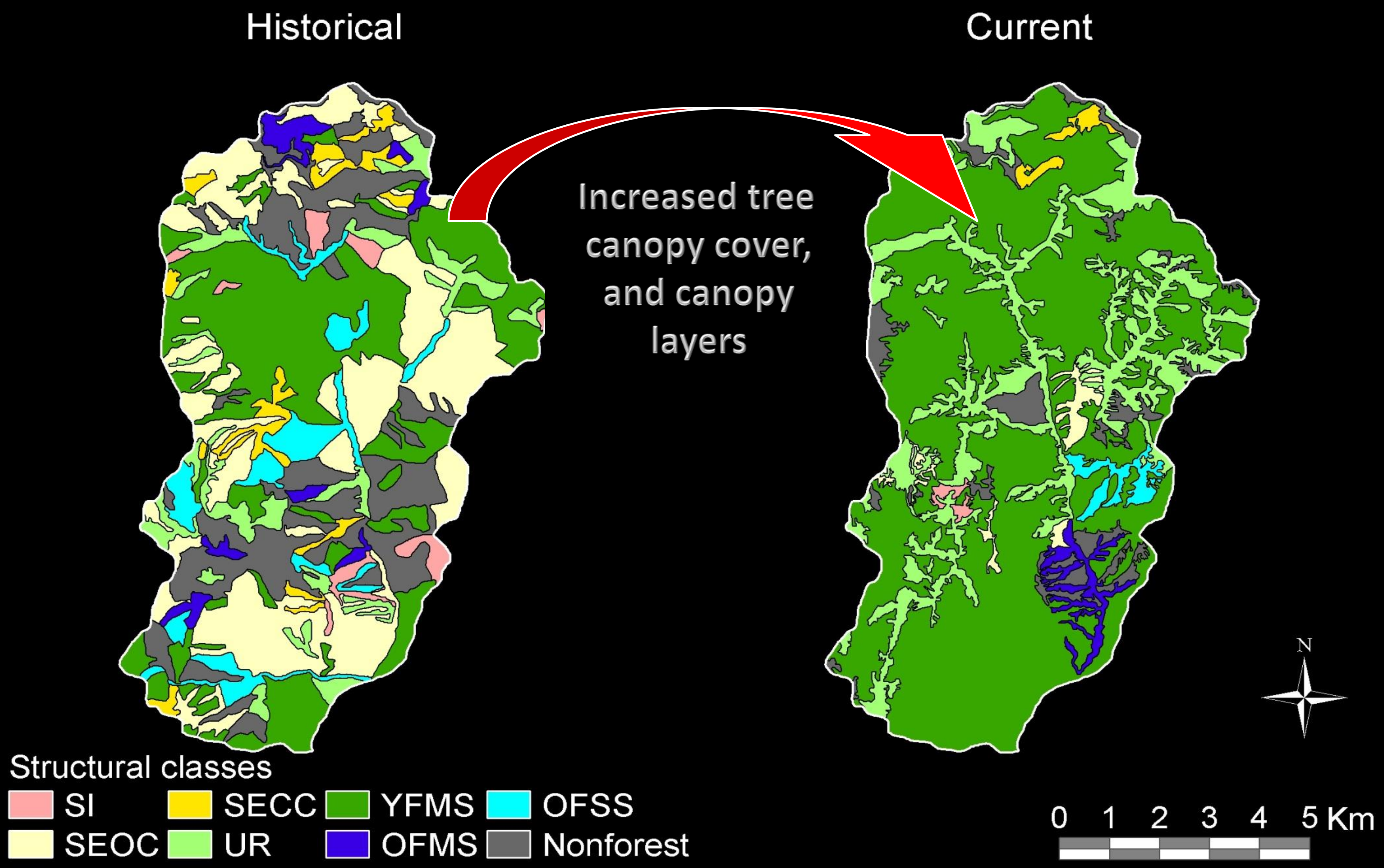
The role of fire suppression…



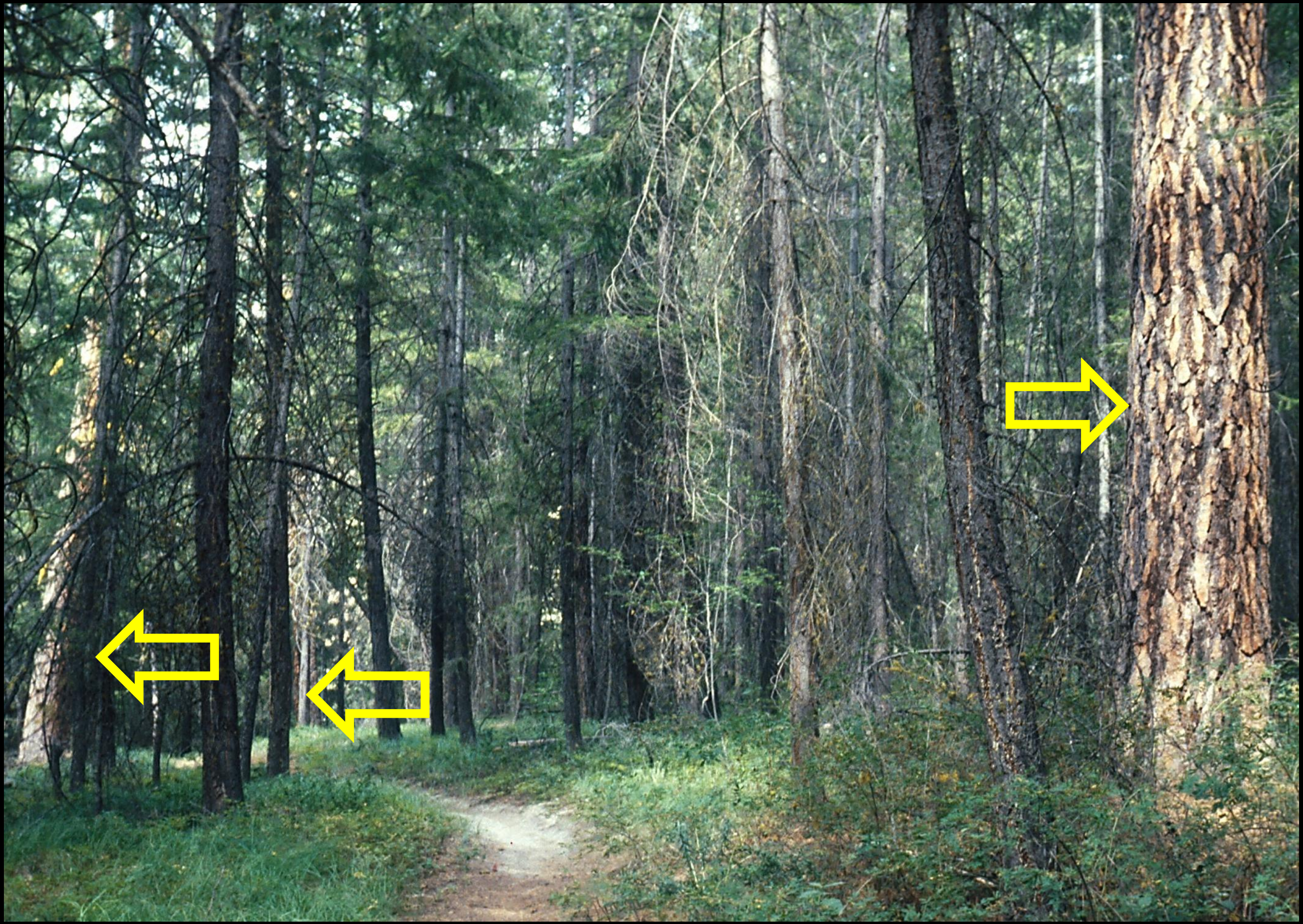
- 1930s, fire suppression began its period of high efficiency
- Suppression works well for 40-50 yrs, aided by a milder climate
- After ~1985, suppression steadily fails to reduce acres burned
- This progression powerfully linked to climate and fuels



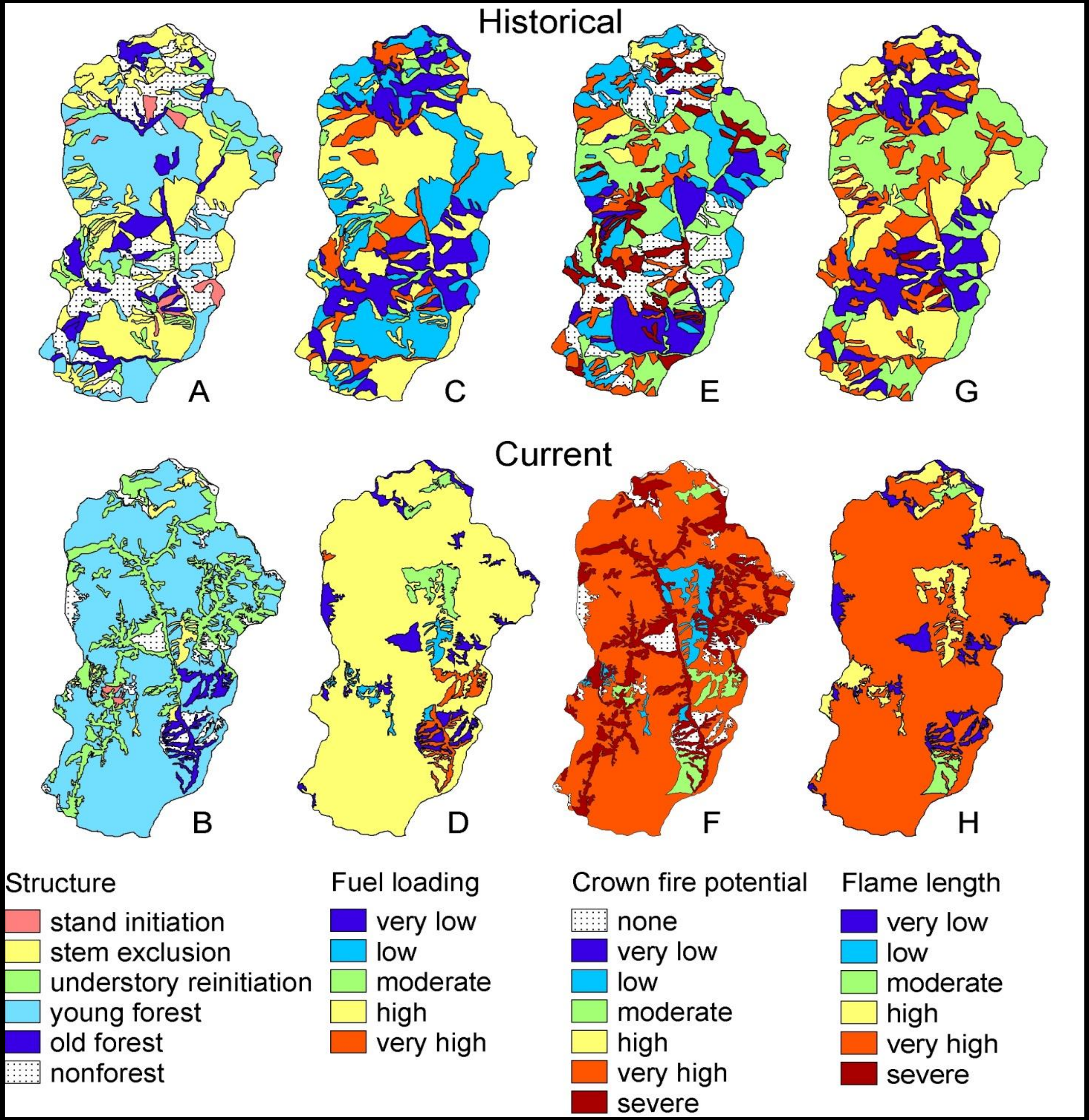
Fire-tolerant cover types decreased, intolerant cover types increased.



All age forest mosaic was replaced by young multi-story forest

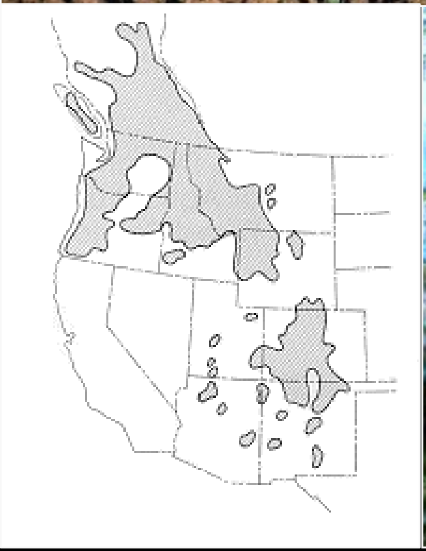


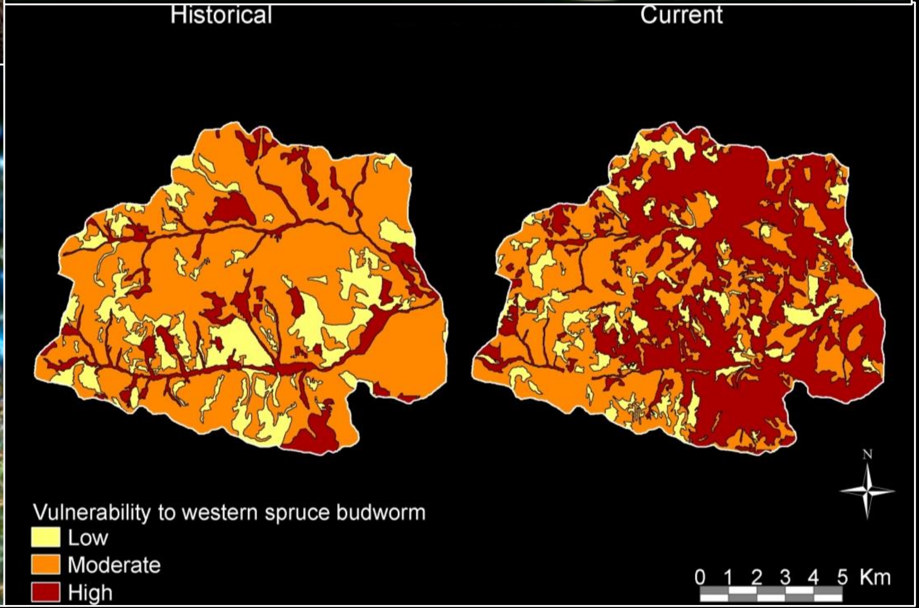
Open stands developed dense layered understories


Historical
A
C
E
G
Current
B
D
F
H
Structure
stand initiation
stem exclusion
understory reinitiation
young forest
old forest
nonforest
Fuel loading
very low
low
moderate
high
very high
Crown fire potential
none
very low
low
moderate
high
very high
severe
Flame length
very low
low
moderate
high
very high
severe

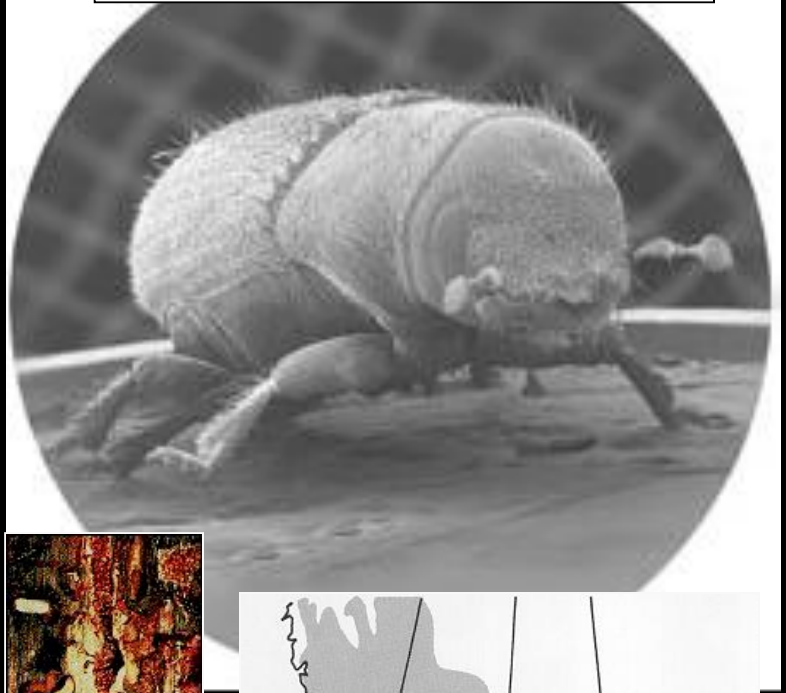

Current
0
5
10 Km

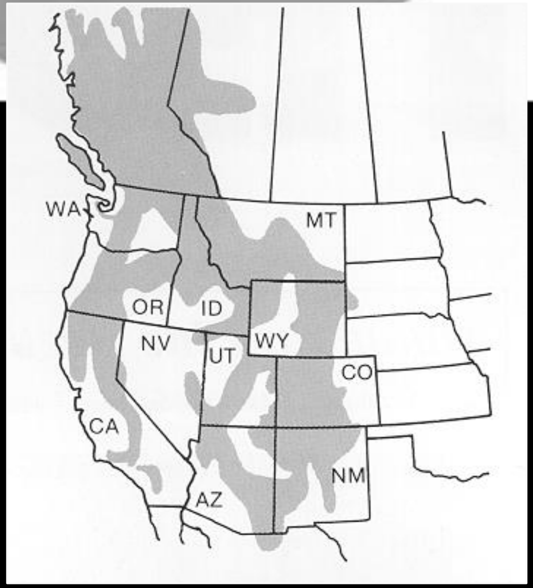
Western spruce budworm

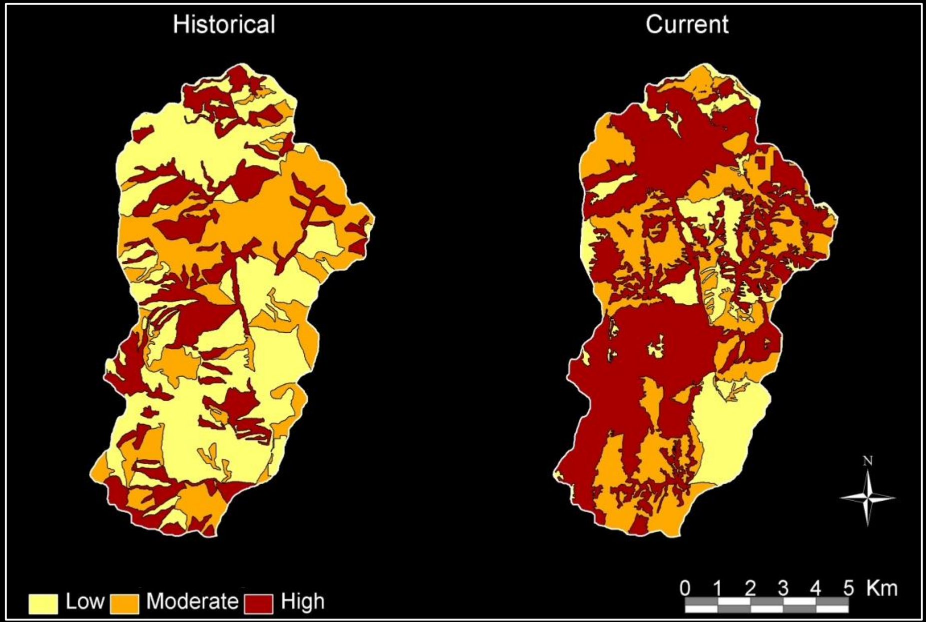




Mountain pine beetle







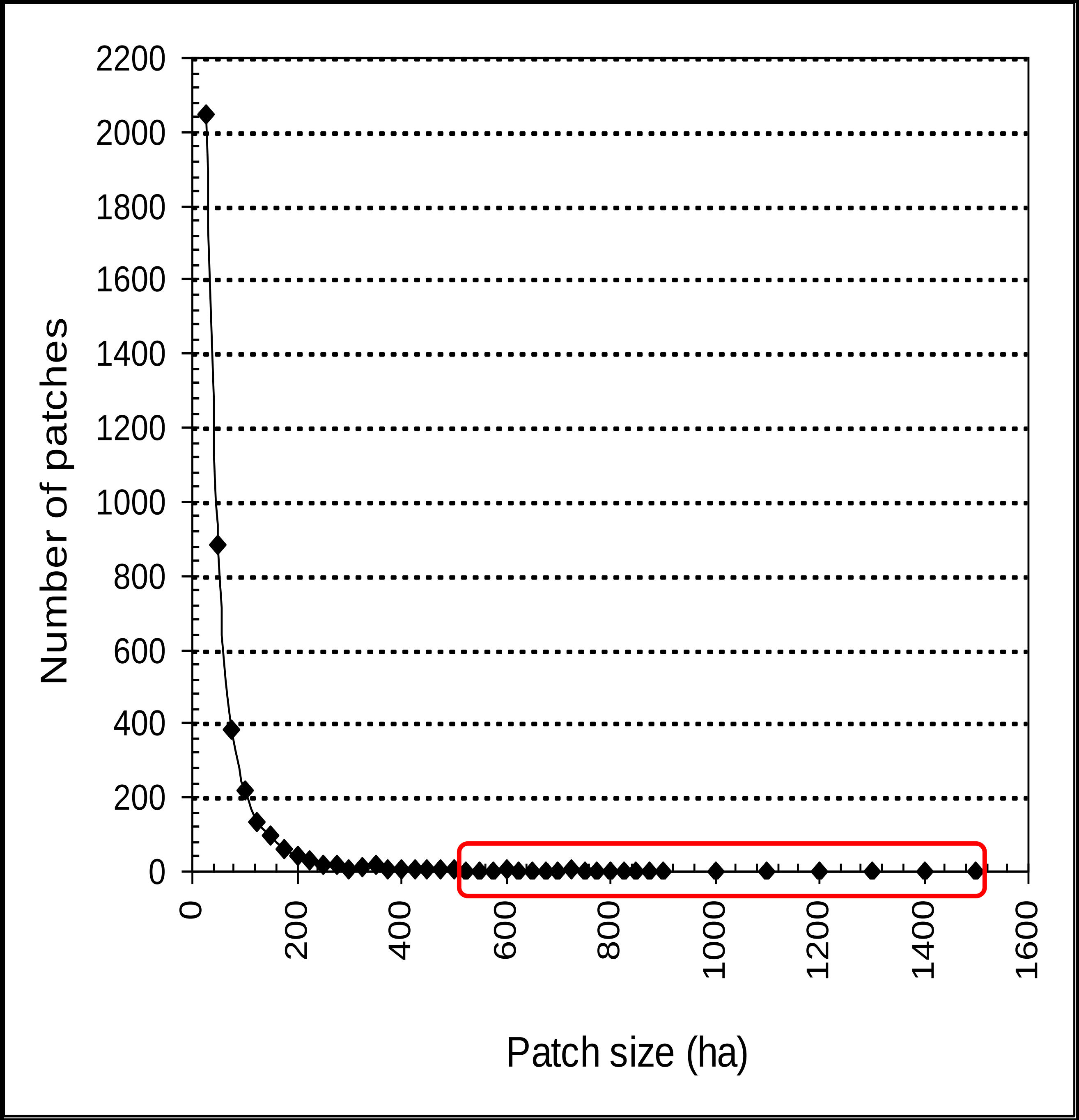
An important role for early seral conditions…

40-50% of the landscape was likely in early seral or pre-forest conditions.

Patch sizes were mostly small- to medium-sized

In distributions that looked like this…

There were occasional large patches too…



What did this early seral patchwork provide?

- ✓ A fast and relatively benign fire delivery system
- ✓ With grasses and shrubs as the primary fuels…
- ✓ Delivering to the interspersed forest patchwork…
  - Rapid fire rates of spread
  - Short flame lengths
  - Low energy release from the surface fuel beds
  - Low fireline intensity
  - Leading to low crown fire initiation & spread potential
- ✓ Too much mature forest area was a “poison pill” to the remainder of the forested landscape.
- ✓ Too much high density forest was a “poison pill” as well…
- ✓ With CC, forest area will continue to reduce, as will forest density

Landscape Ecol
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REVIEW ARTICLE

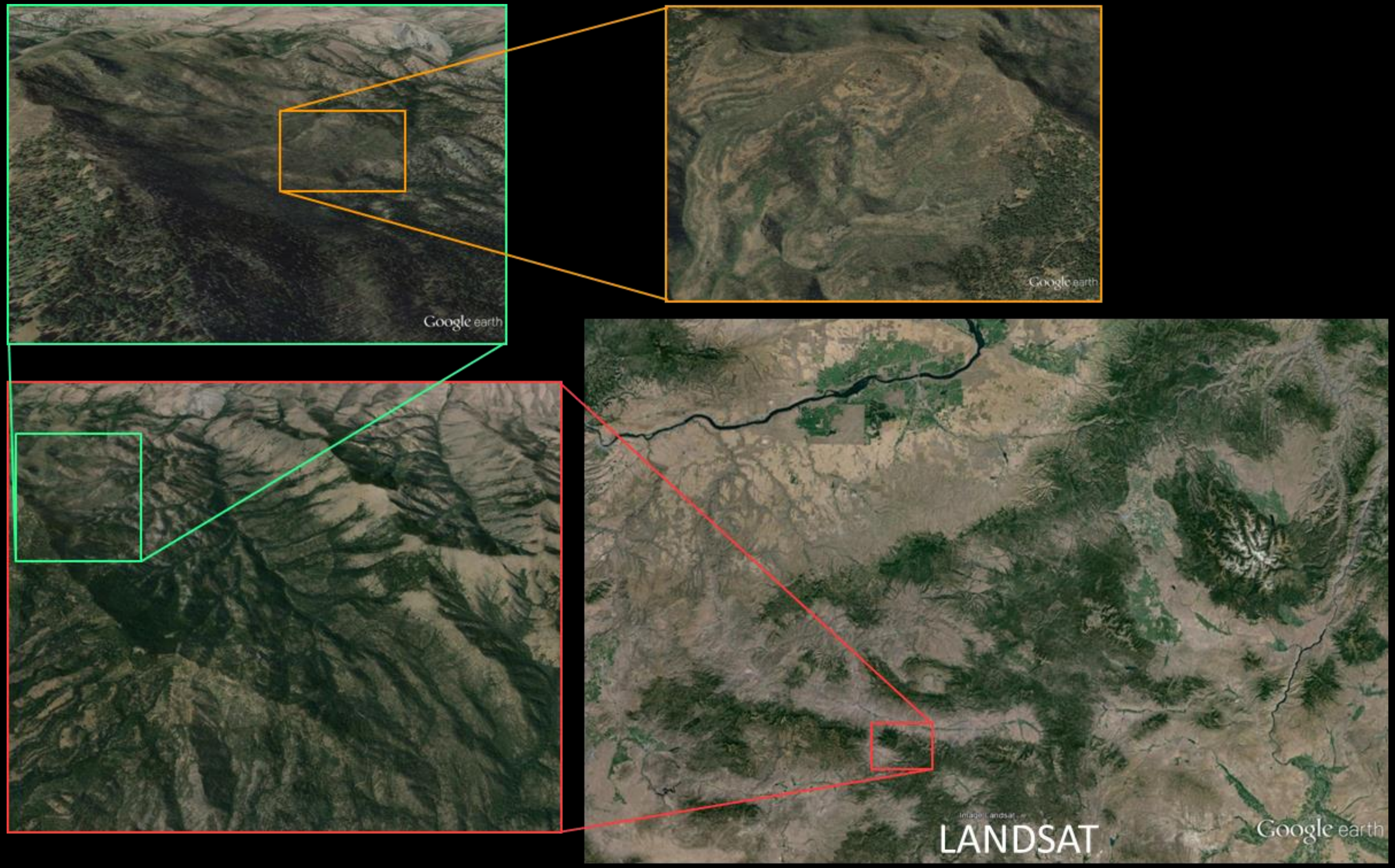
Restoring fire-prone Inland Pacific landscapes: seven core principles

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

Landscape Restoration: **Core Principle 1**

Regional landscapes are multi-scale, nested patchworks

Restore patterns, connectivity, and processes at each level



e.g., Blue Mountains Province

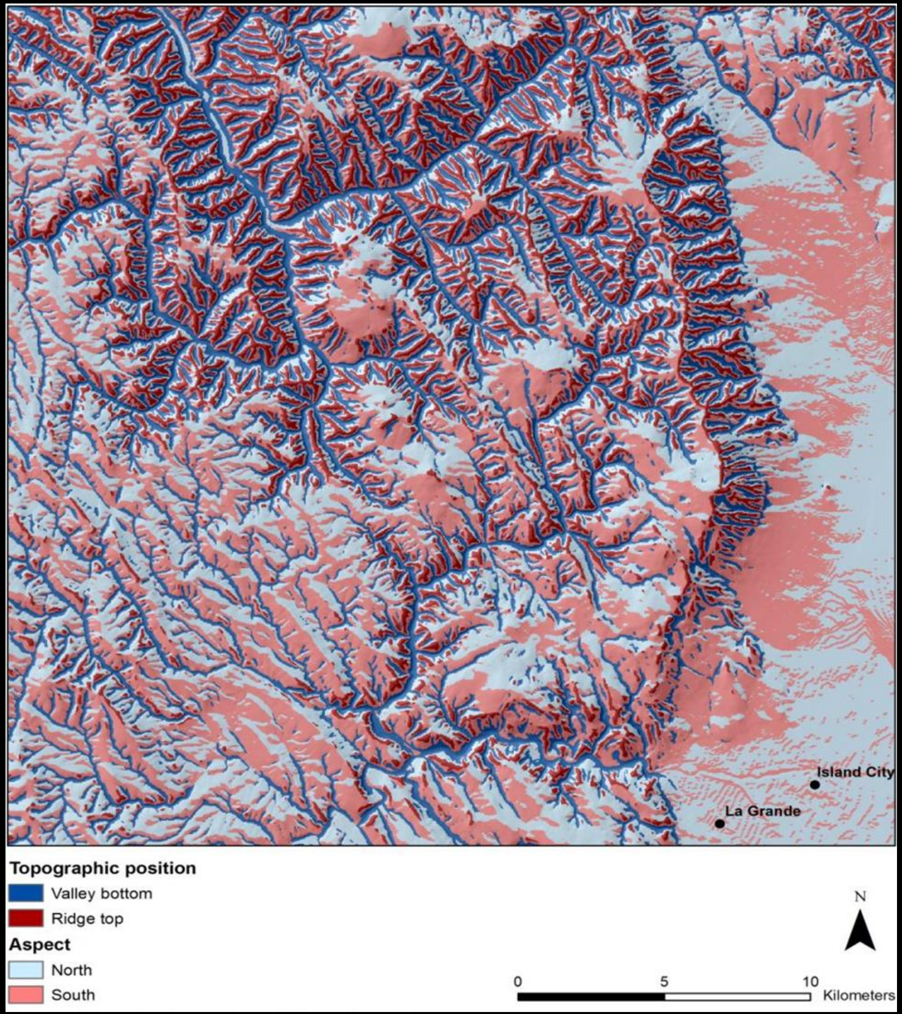
Wu J., & Loucks, O. L. 1995. Quarterly Review of Biology, 439-466

O'Neill 1986, Urban et al. 1987, Holling 1992, Wu & David 2002

Landscape Restoration: **Core Principle 2**

Topography provides a natural template for vegetation & habitat patterns

Use topography (and soils) as a template for fitting more characteristic successional and lifeform patterns to the landscape

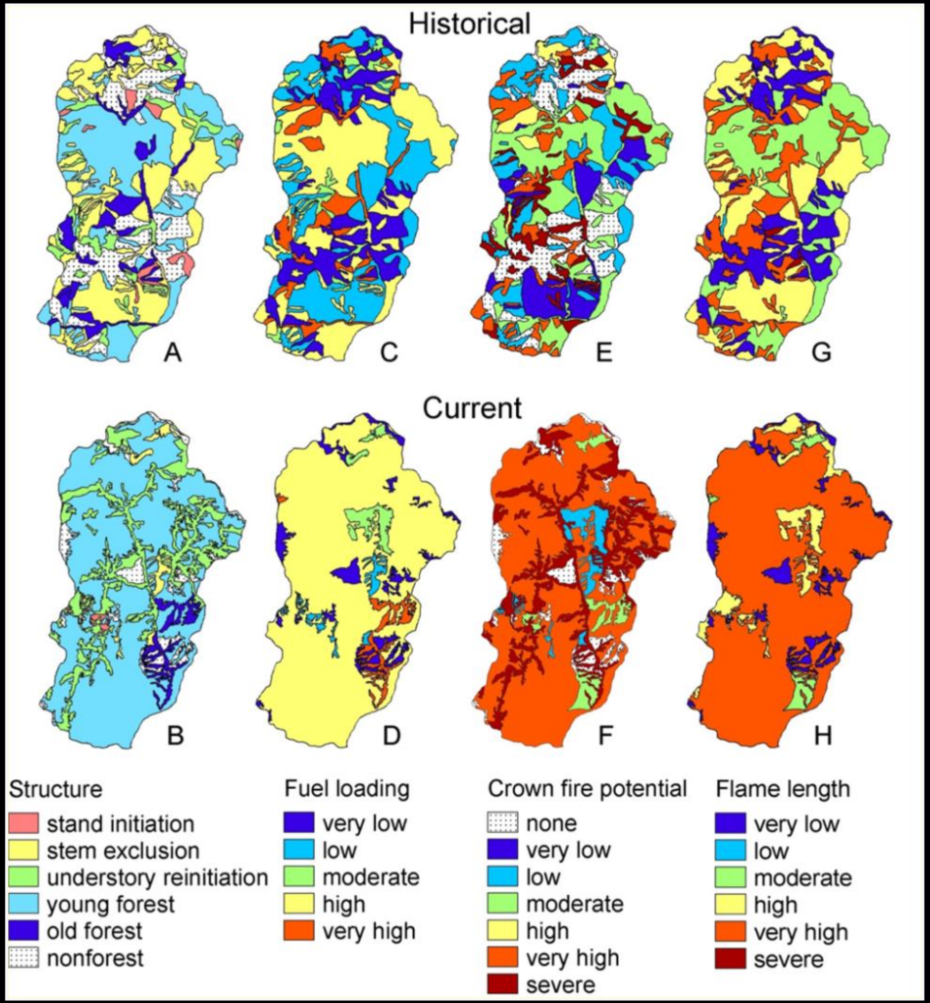


Perry et al. (2011) For Ecol & Mgt 262:703
Lyderson & North (2012) Ecosystems 15: 1134

Landscape Restoration: **Core Principle 3**

Fire and forest succession are the engine that drives the system

Restore supportive successional/fuel patterns to restore the fire regime; CC will continually adapt these patterns

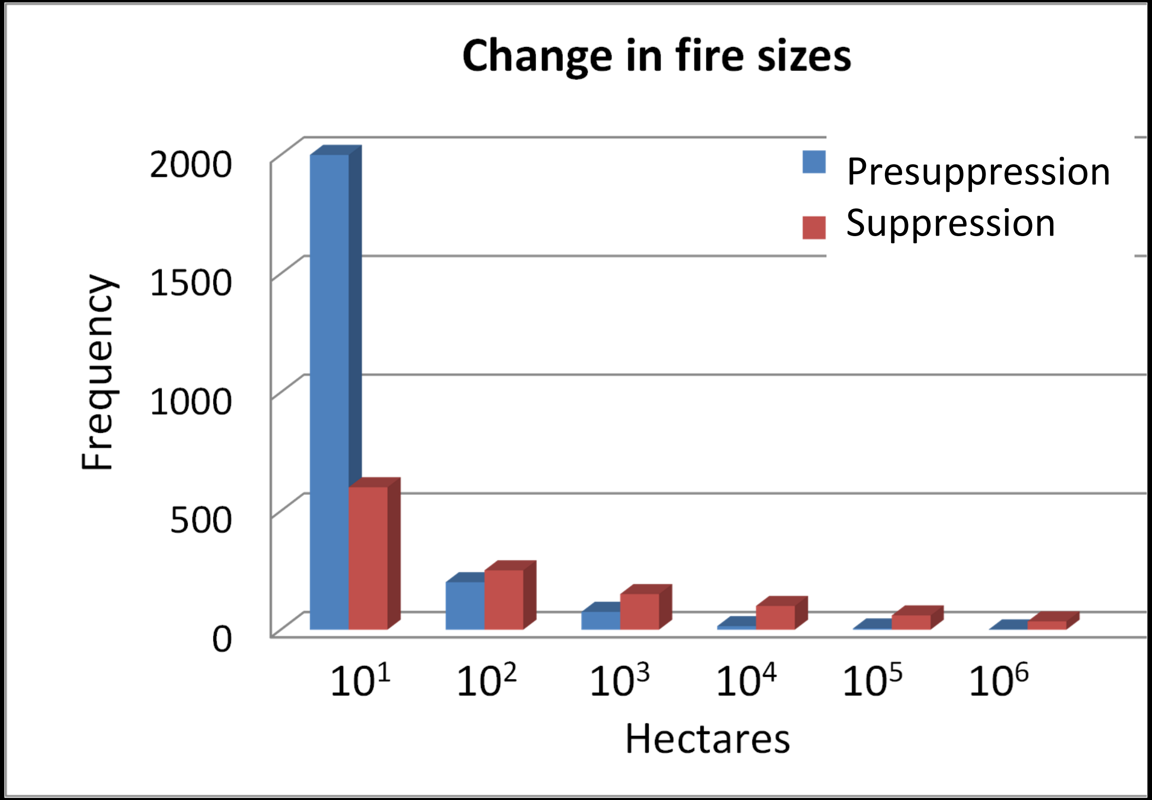


Keane et al. (2009) For Ecol Manage 258:1025-1037
Bisson et al. (2009) Ecol & Soc 14(1), 45;
Collins et al. 2009, Parks et al. 2015;
McGarigal & Romme 2012;
Wiens et al. (2012) Hist. Env Variation… Wiley-Blackwell

Landscape Restoration: **Core Principle 4**

Predictable patch size distributions historically emerged from landscape-climate interactions

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



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

Perry et al. 2011. Forest Ecology and Management 262: 703-717.

Landscape Restoration: **Core Principle 5**

Widely distributed Med & Lg older trees provide a critical backbone to PP, DMC, MMC landscapes; they are CC and wildfire adapted

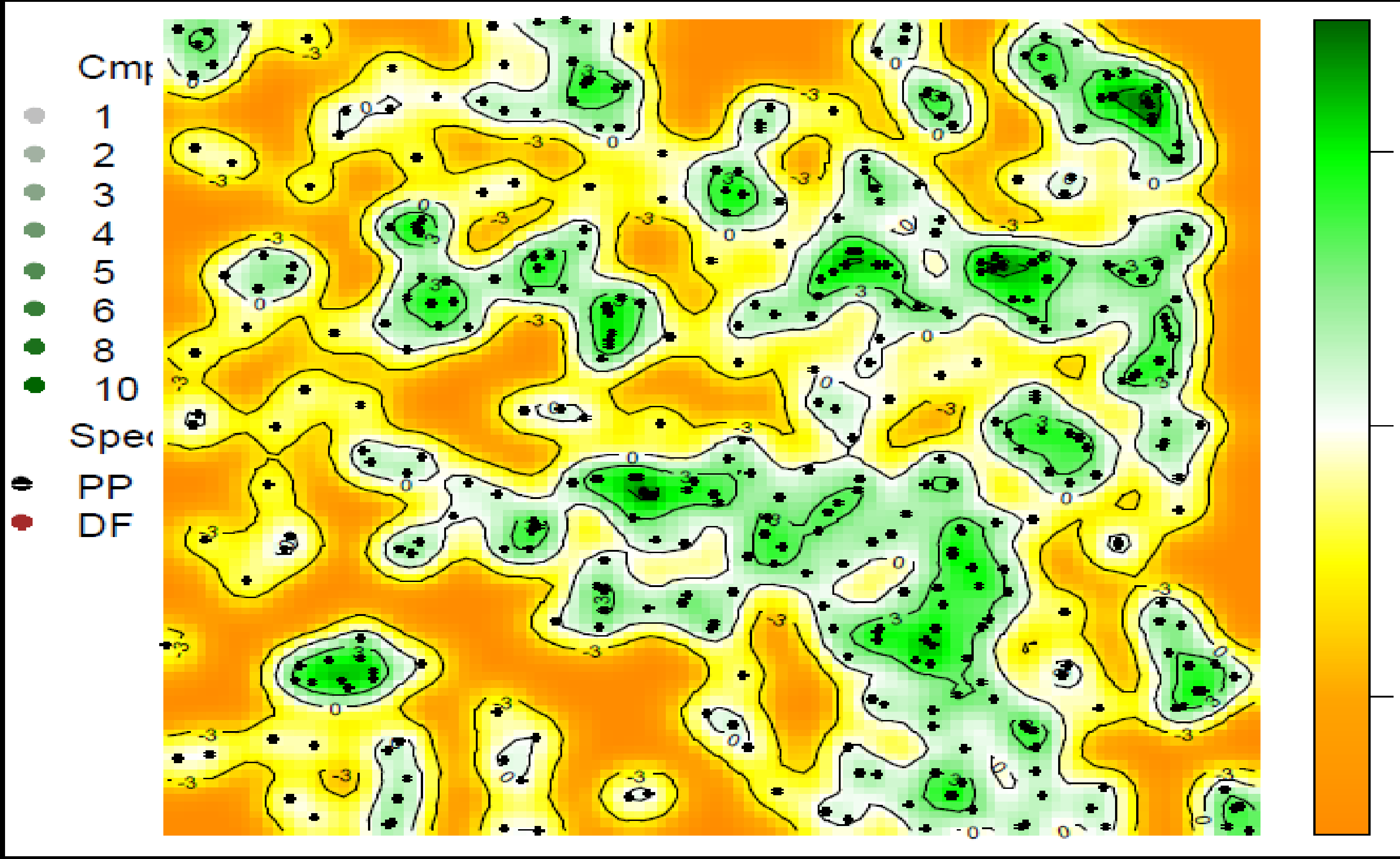
Consider retaining what you have and making more of them

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

Landscape Restoration: **Core Principle 6**

Successional patches are "landscapes within landscapes"

In PP & DMC & MMC patches, restore characteristic tree clump & gap variation

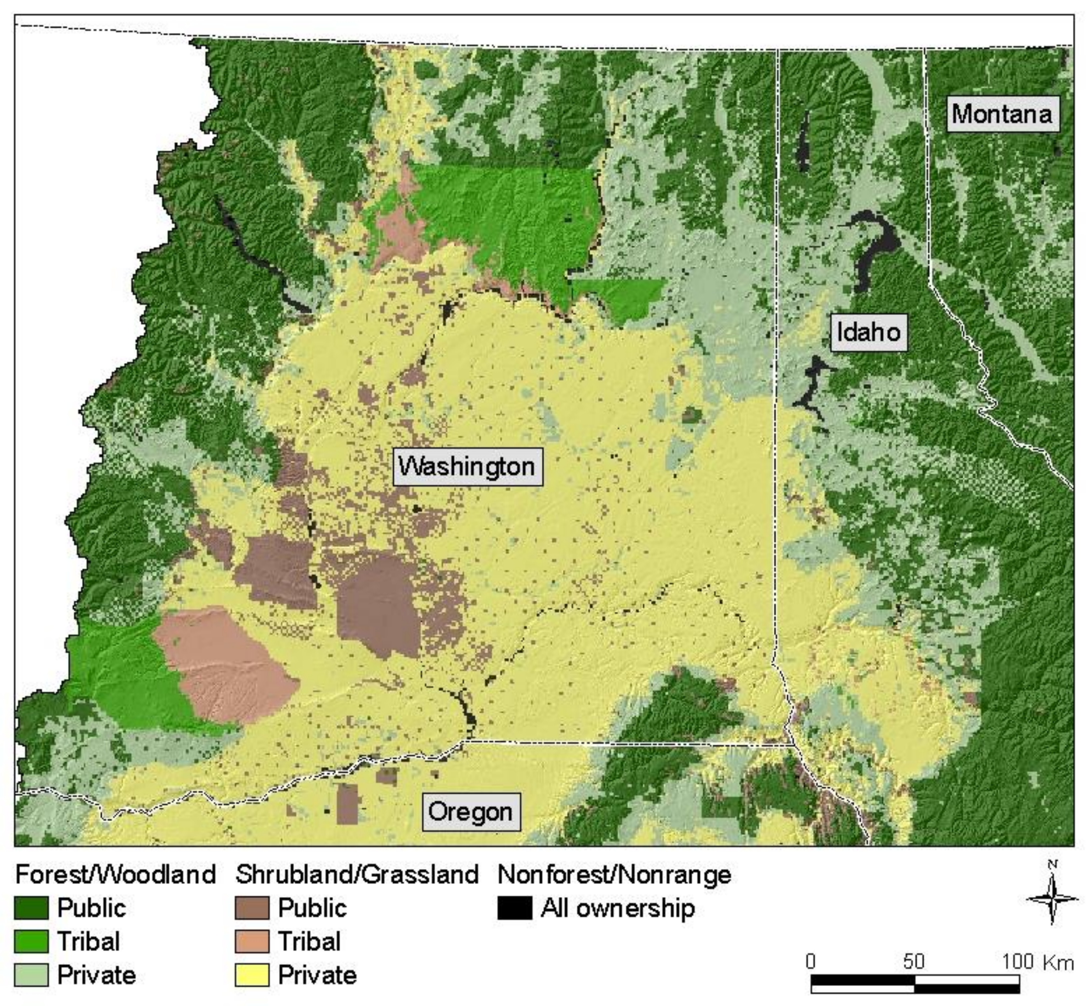


Larson & Churchill (2012) For Ecol Manage 267: 74-92
Churchill et al.(2013) For Ecol Manage 291: 442-457
Lydersen et al. (2013) For Ecol Manage 304: 370-38

Landscape Restoration: **Core Principle 7**

Land ownership & allocation patterns disrupt landscape patterns

Work collaboratively across ownerships to develop restoration projects



Cheng & Sturtevant (2012) Env Mgt 49:675-689

Rieman et al. (2015) Fisheries, 40:124-135

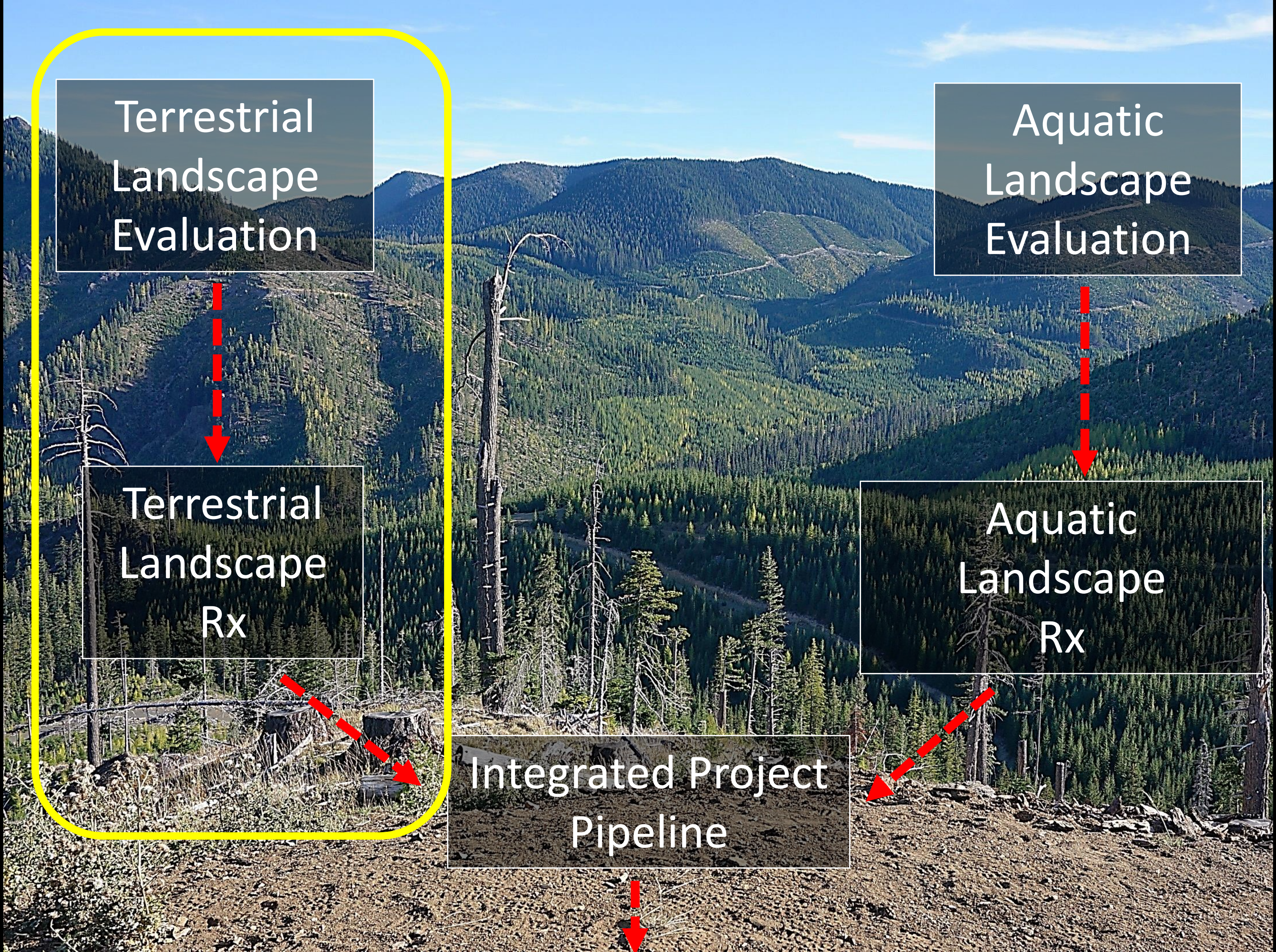
Landscape scale prescriptions that alter fuel & successional patterns across ownerships can help get you there.

- ✓ This means being open to a potential cultural change in forest planning and management…
- ✓ …from doing stand management at large scales, and calling it landscape restoration…
- ✓ To understanding the key departures of existing large landscapes from their more natural pattern of variability
- ✓ And building a portfolio of spatially allocated treatments to restore those patterns
- ✓ … and then allowing CC to continue to modify these patterns

Questions?

Applying the Principles
...to develop
Landscape Level Prescriptions


Set the context for "whole landscape" restoration & coordinated,
spatially specific treatments across ownerships.


Terrestrial Landscape Evaluation
Terrestrial Landscape Rx
Aquatic Landscape Evaluation
Aquatic Landscape Rx
Integrated Project Pipeline

United States Department of Agriculture

Forest Service

Pacific Northwest Region

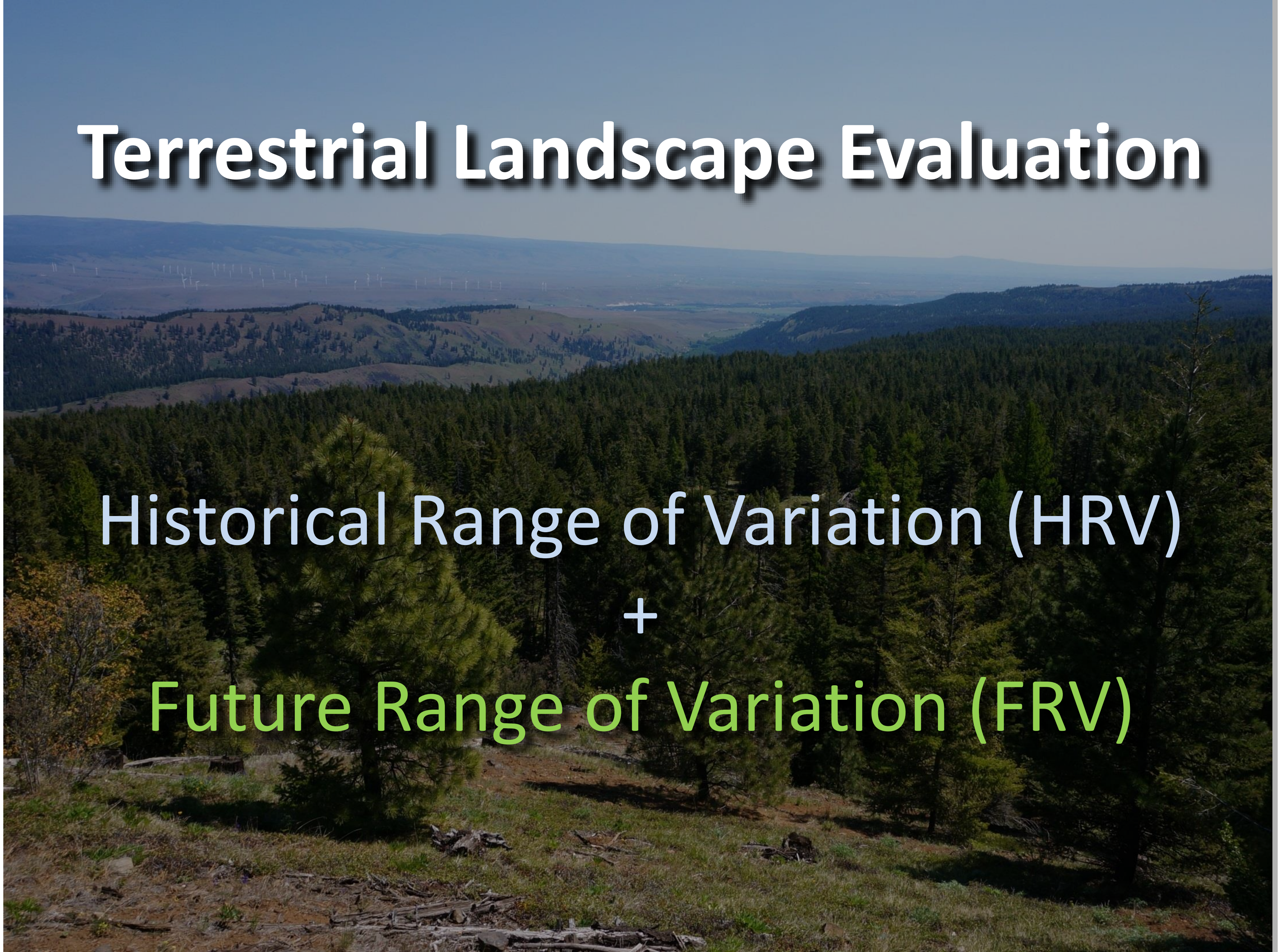
The Okanogan-Wenatchee National Forest Restoration Strategy: adaptive ecosystem management to restore landscape resiliency

2012 Version

Okanogan-Wenatchee National Forest

November 2012

Copies are available online…

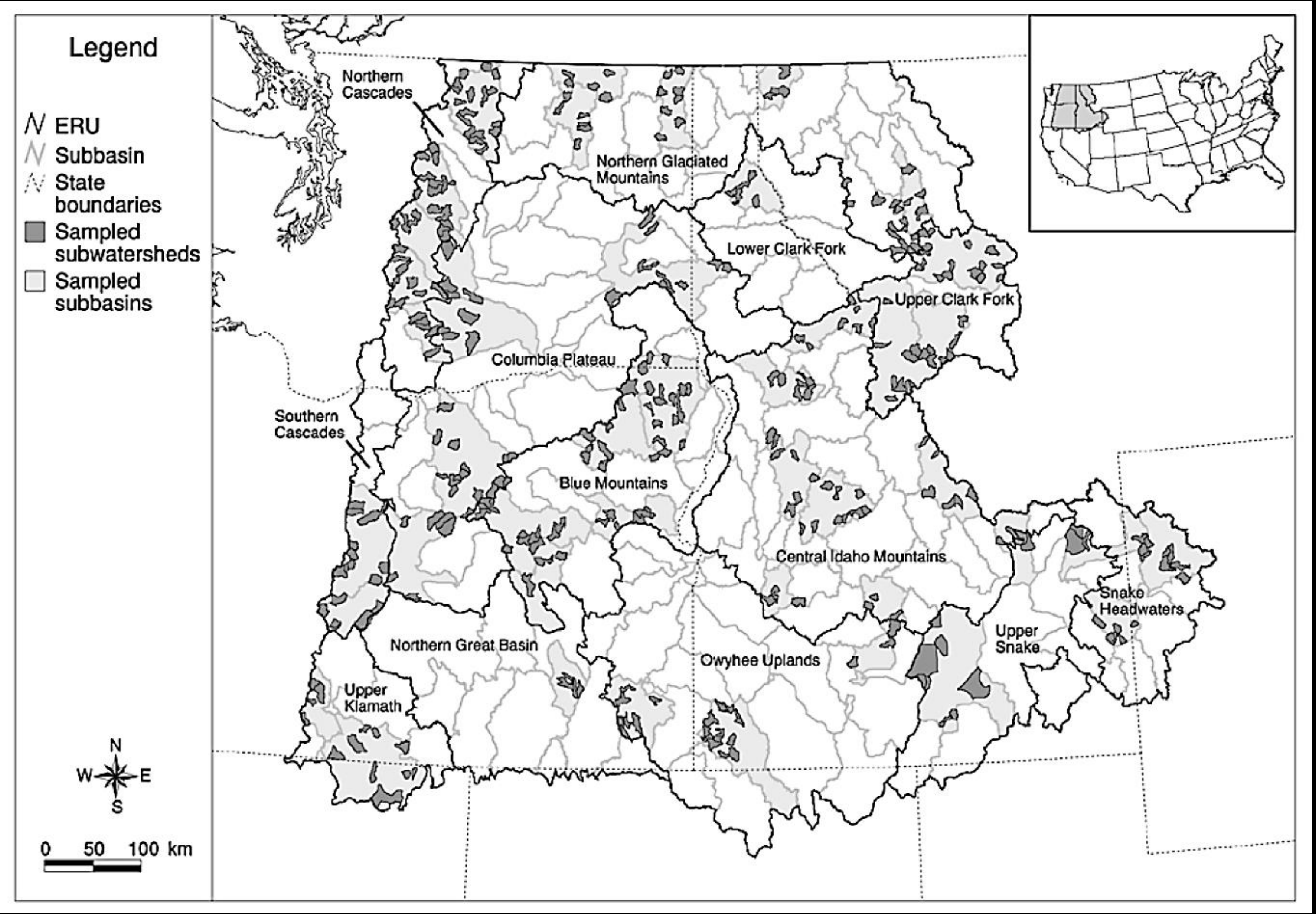


Terrestrial Landscape Evaluation

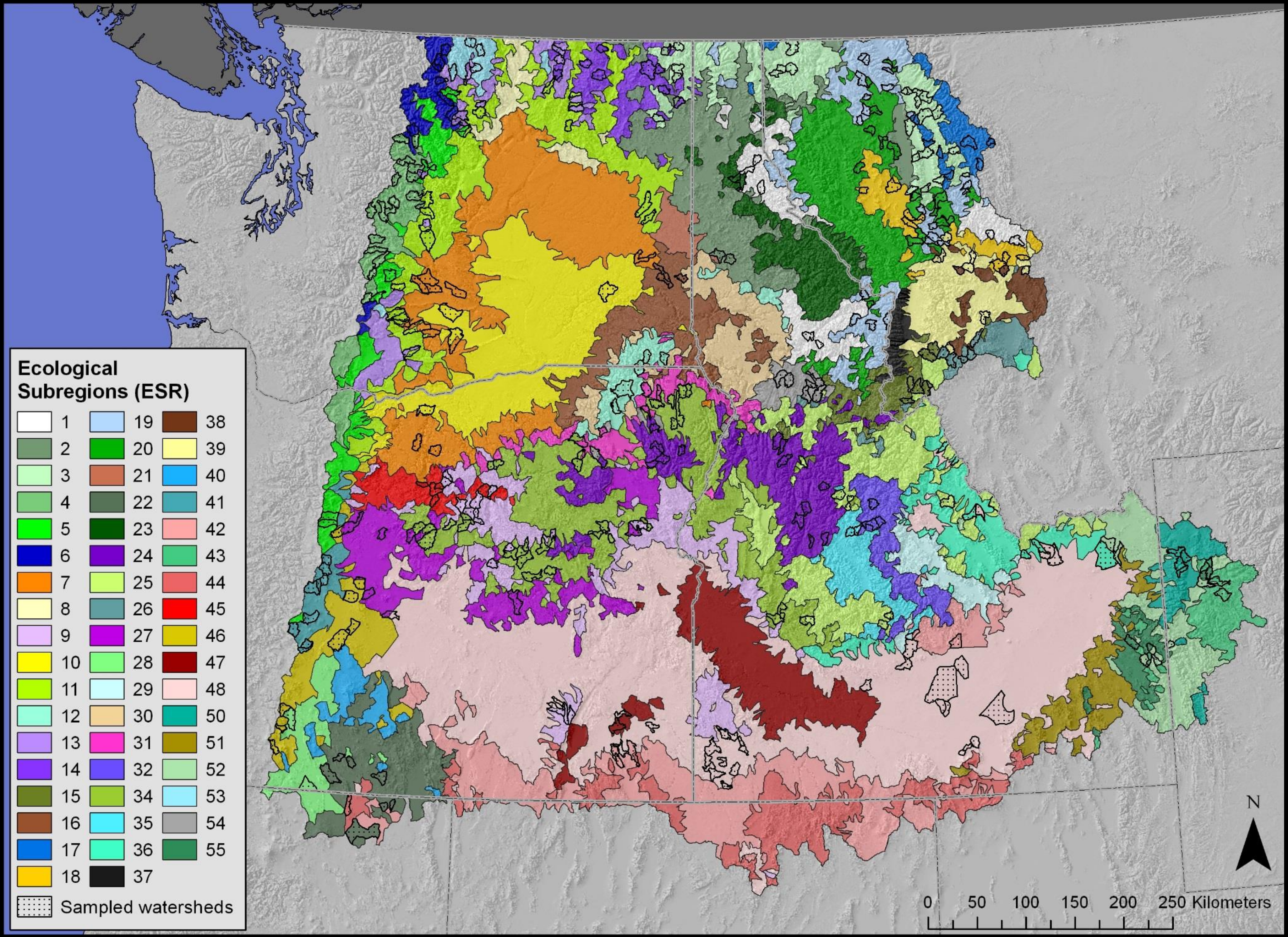
Historical Range of Variation (HRV)

+

Future Range of Variation (FRV)



Hessburg et al. 2000. For. Ecol. Mgt. 136: 53-83.

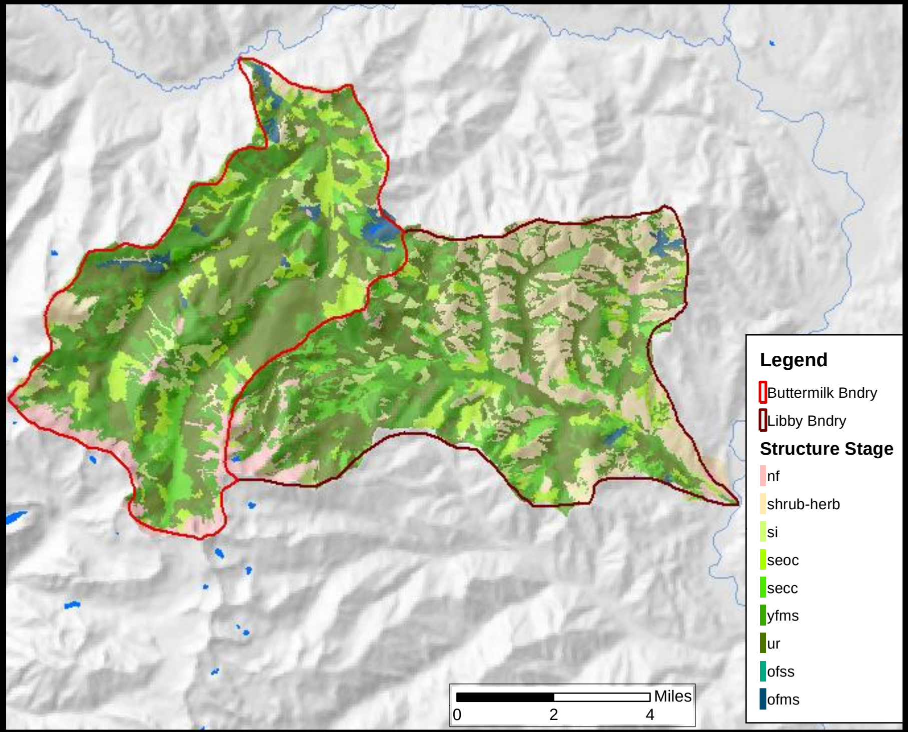


Hessburg et al. 2000. Applied Vegetation Science 3: 163-180

Landscape Evaluation Goals

1. Assess current condition & diagnose departure of the structure, composition, & pattern of any watershed from its HRV and a likely FRV (RCP 6.0 or other)
   - Assess habitat departures for listed & focal species
   - Assess changes in seral stage patterns and vulnerability to I&D, wildfires
   - Assess what would more typical vulnerability look like

2. Develop a Landscape Rx
   - Addressing departures in patterns and abundances of a variety of conditions
   - Develop guidance for whole watersheds
   - Apply it across ownerships
   - Yields a portfolio of priority treatment areas
   - A landscape Rx



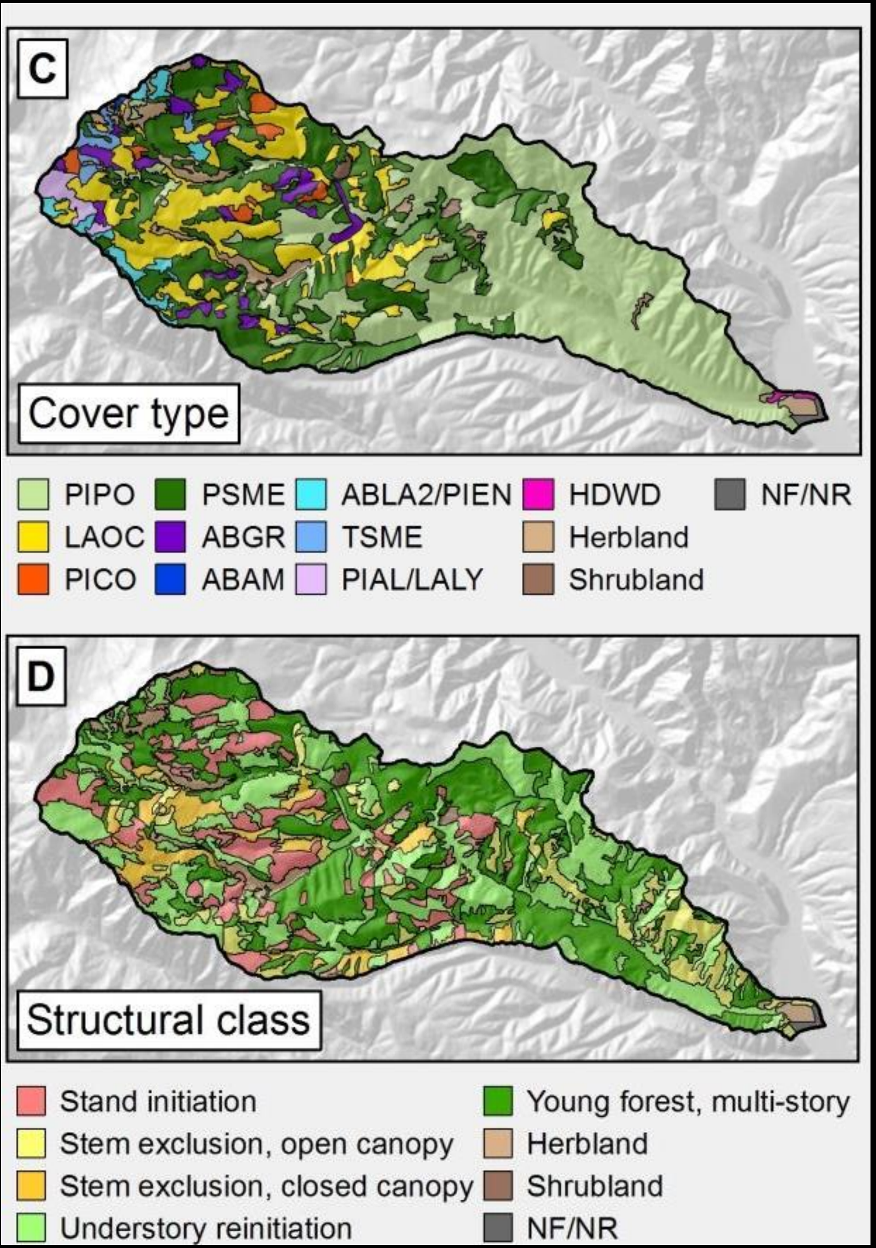
Delineate polygons and collect photo-interpreted data

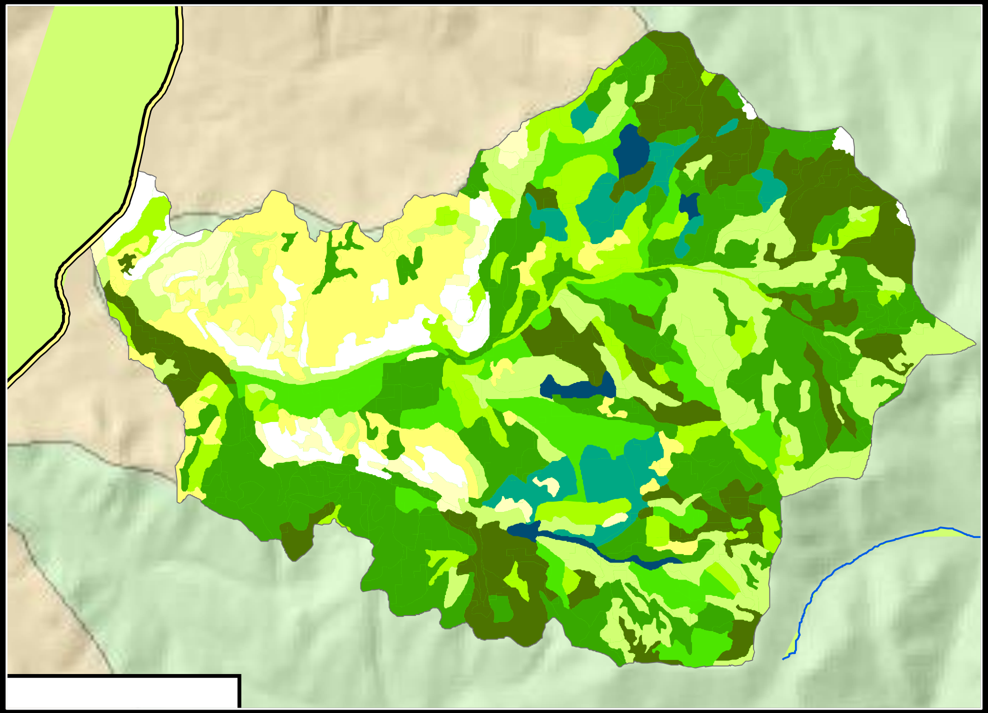
High Resolution Stereo
Head's up digitizing

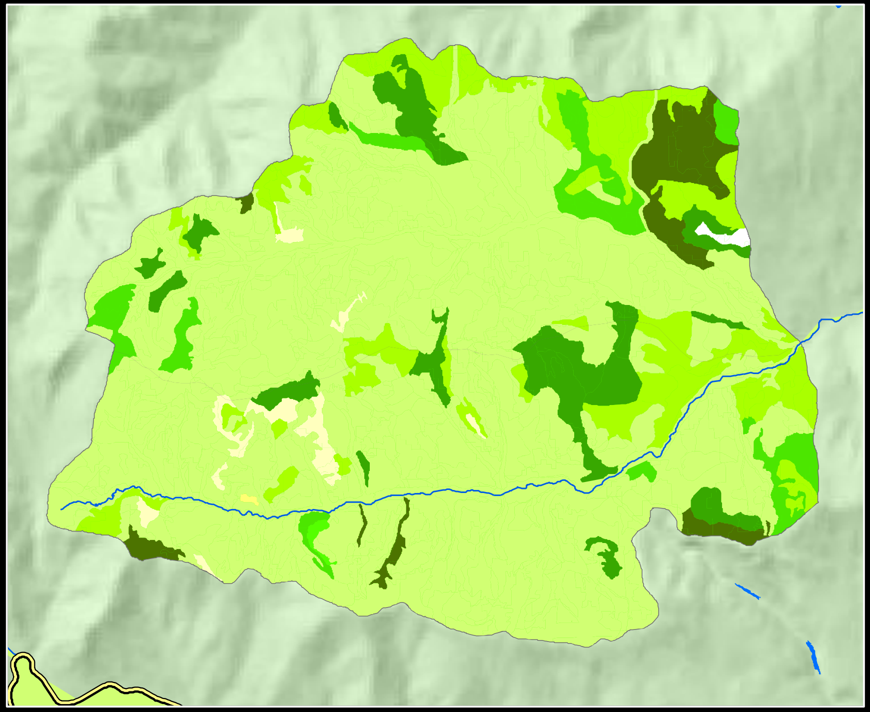
- % Canopy cover, Tot/US/OS
- # Canopy layers
- Size classes of trees OS/US
- Spp. composition OS/US
- Dead tree/Snag abundance
- Clumpiness of trees
- Many others …

Derived attributes

- Structure Class
- Cover Type
- Canopy Cover classes
- Large tree cover
- WL Habitat Indices
- Fire behavior ratings
- Fuel loadings
- I & D hazard ratings







Evaluate spatial patterns w/ FRAGSTATS

Class metrics

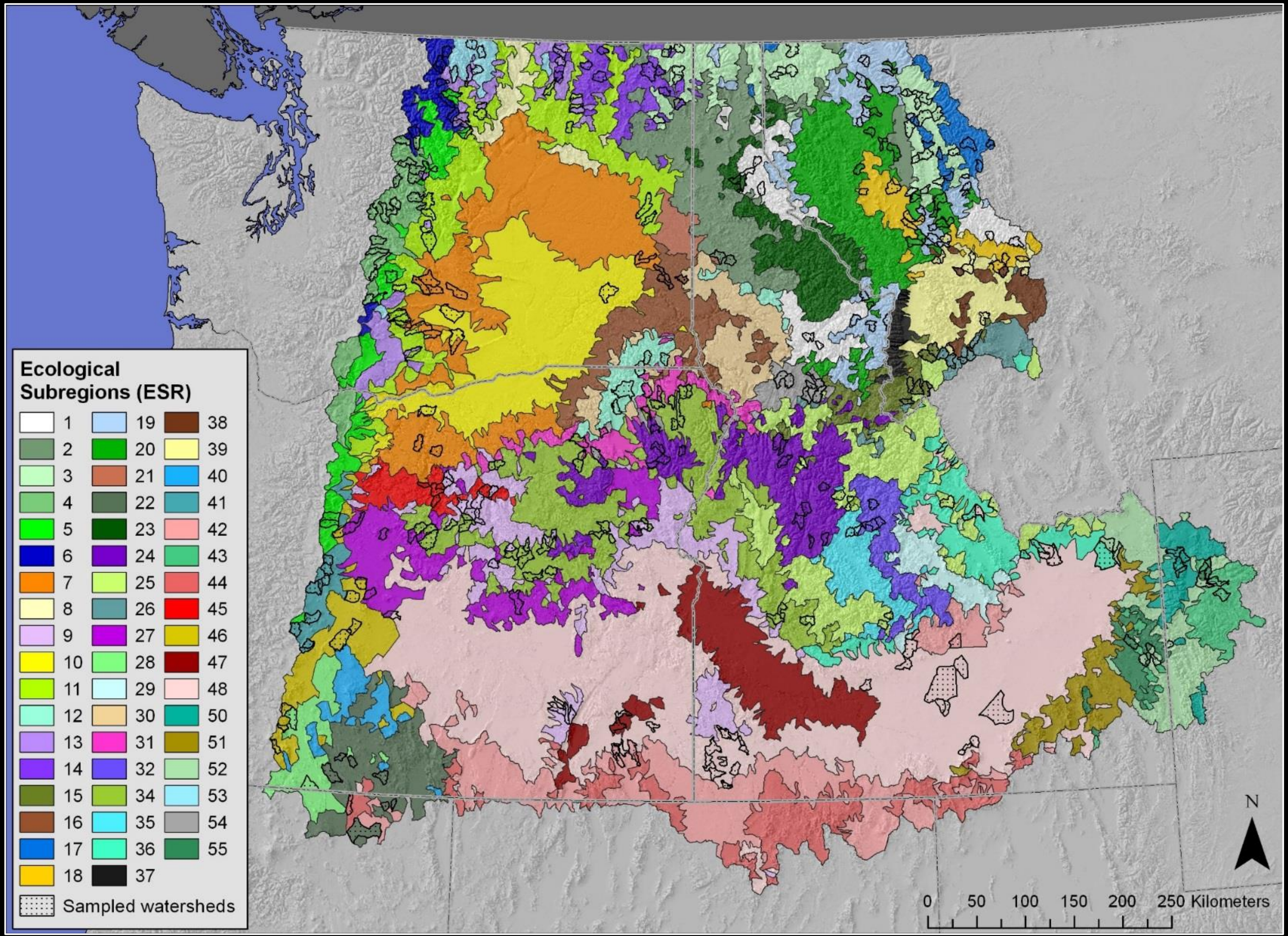
- Percent Area
- Mean patch size
- Largest patch index
- Mean nearest neighbor distance
- Patch density (#/10,000 ha)

Landscape metrics

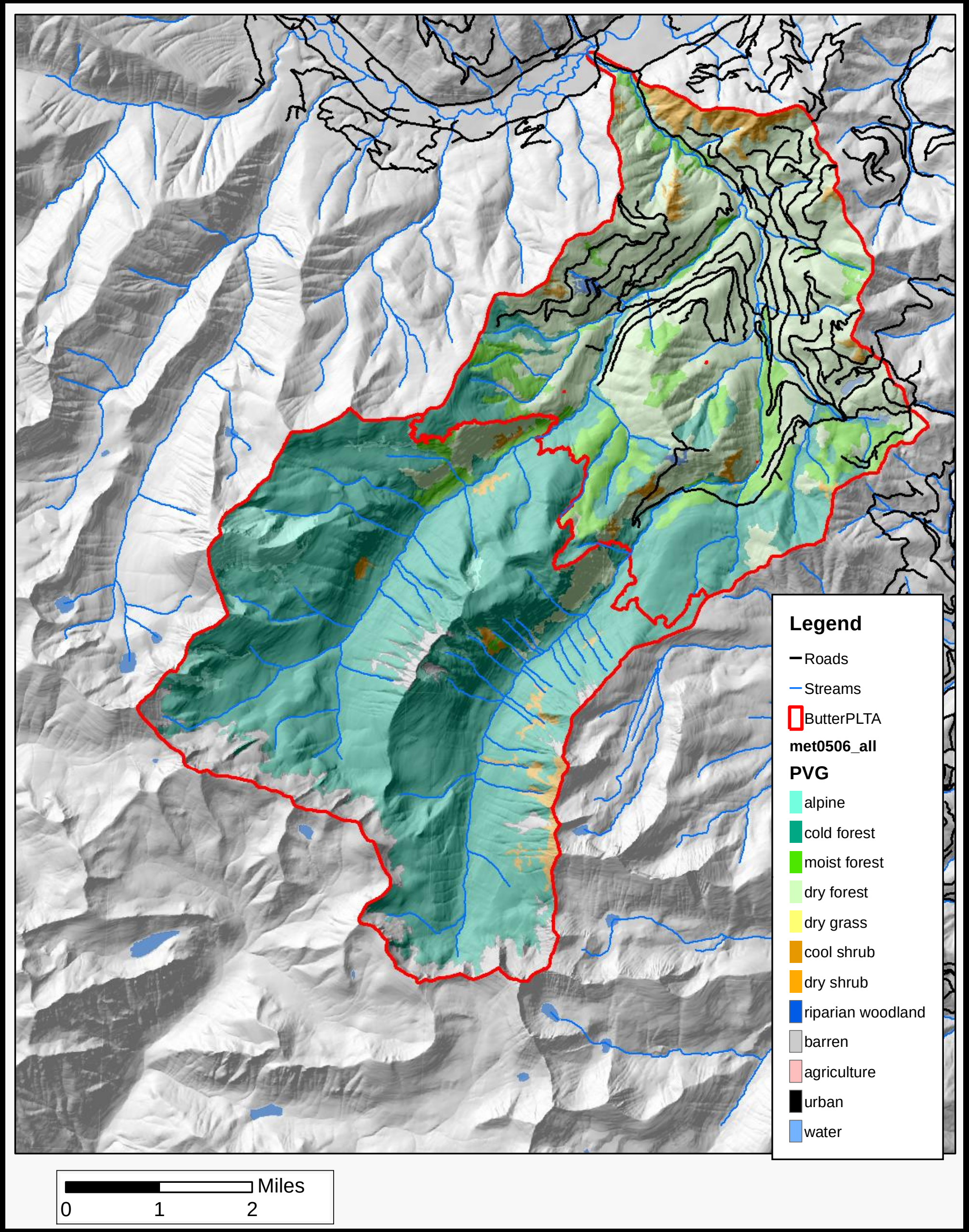
- Interspersion, dispersion, contagion, diversity

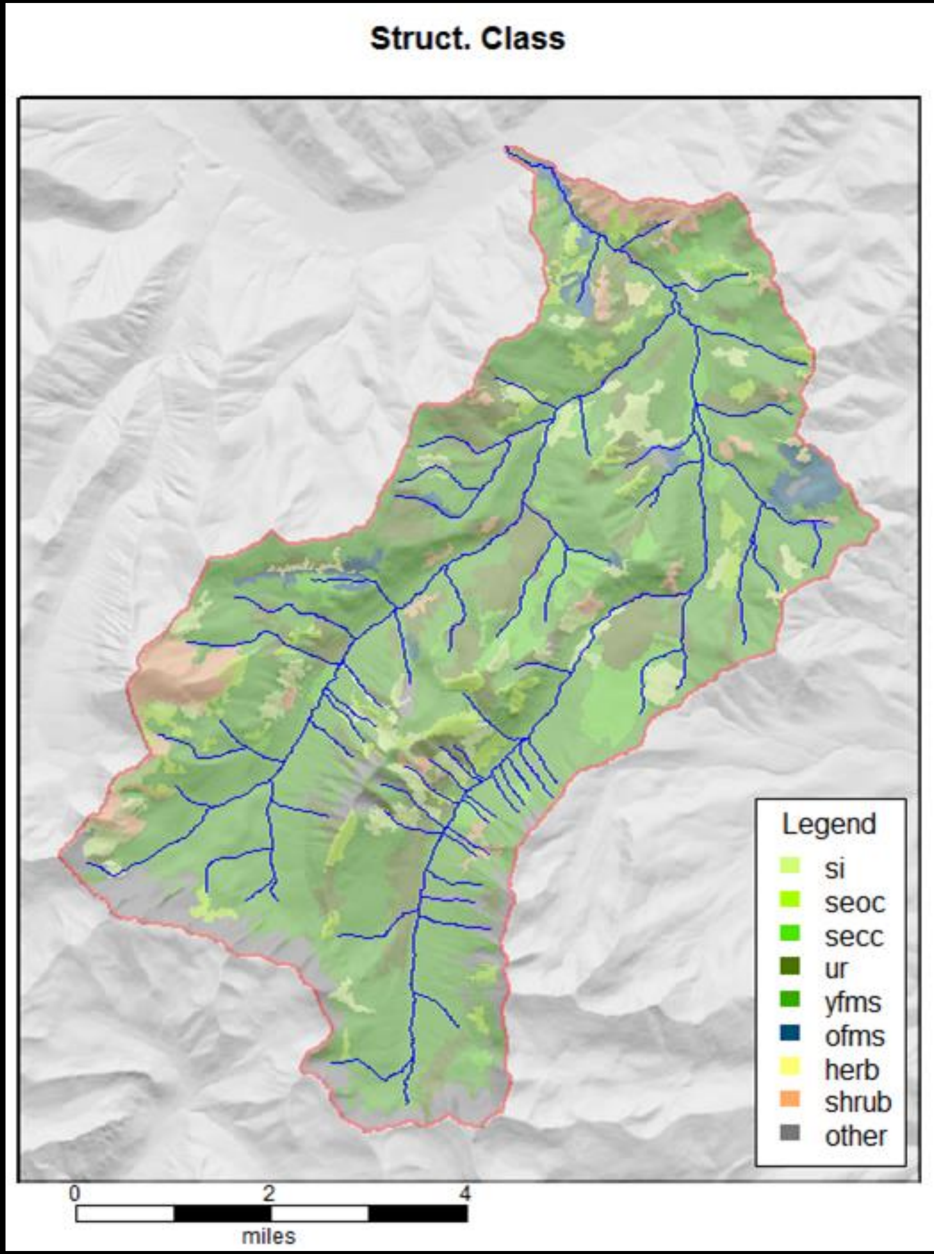
Evaluating Departure

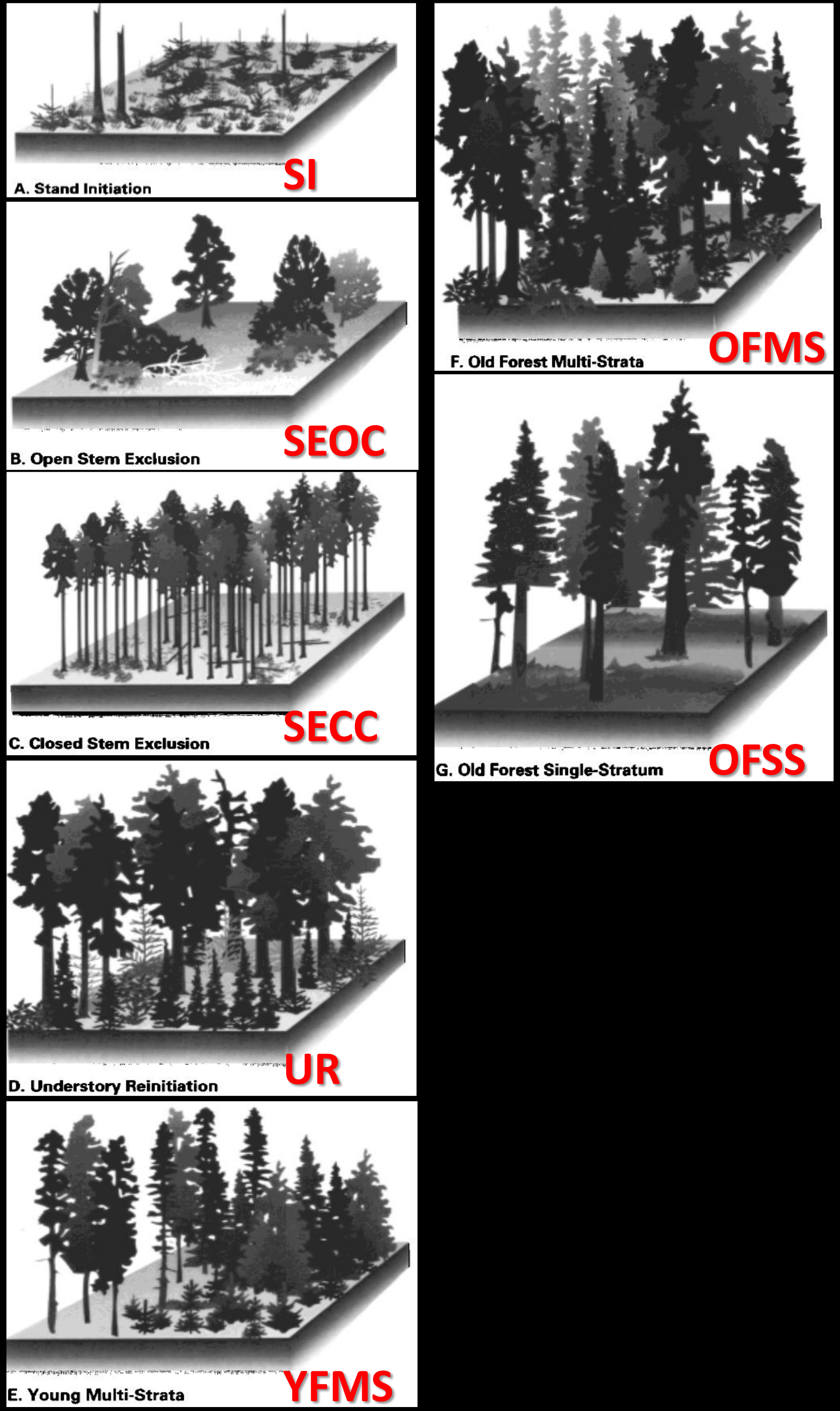
Comparing current conditions to HRV & FRV ranges of conditions



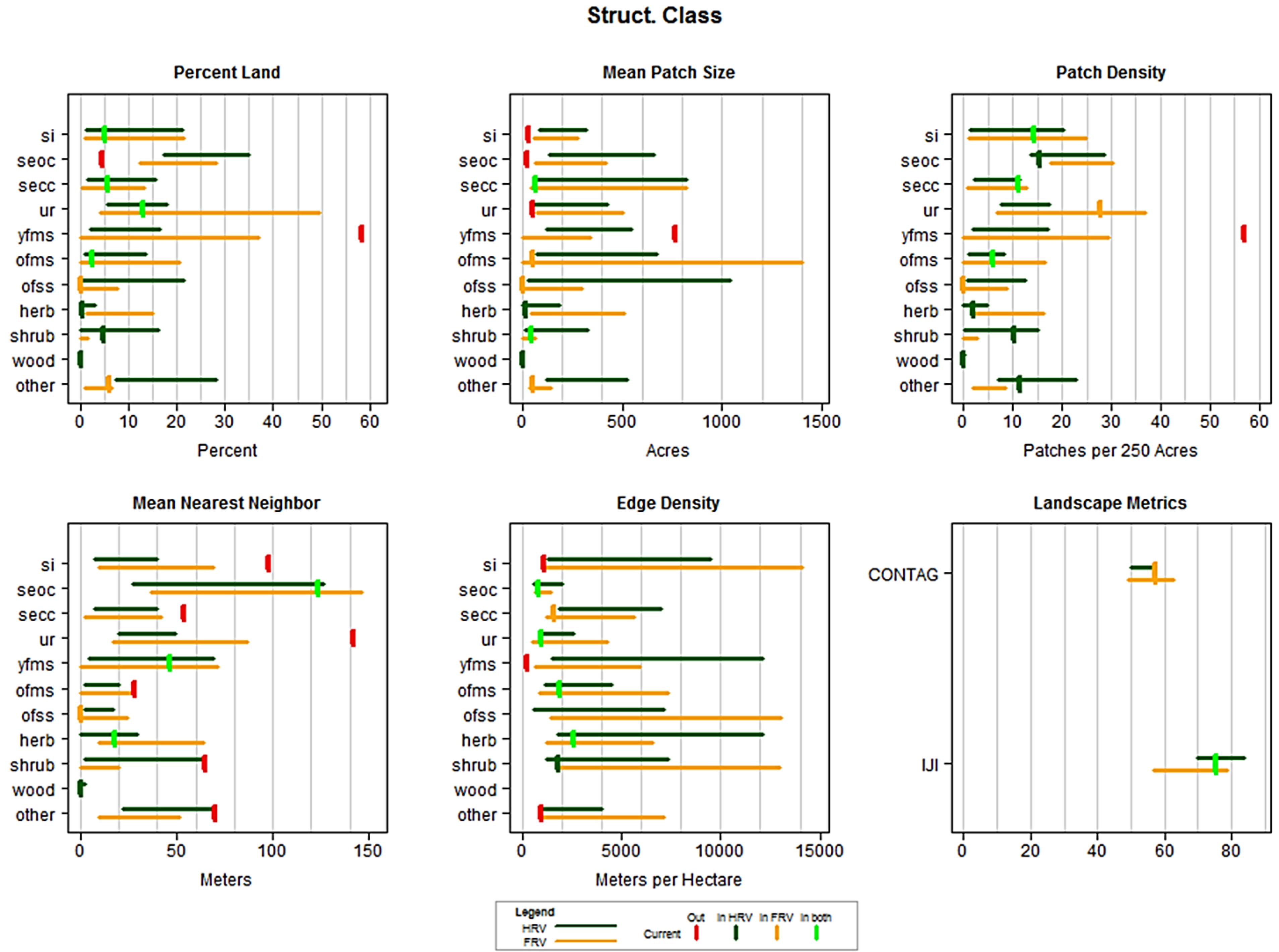
Potential Vegetation Groups (PVG)





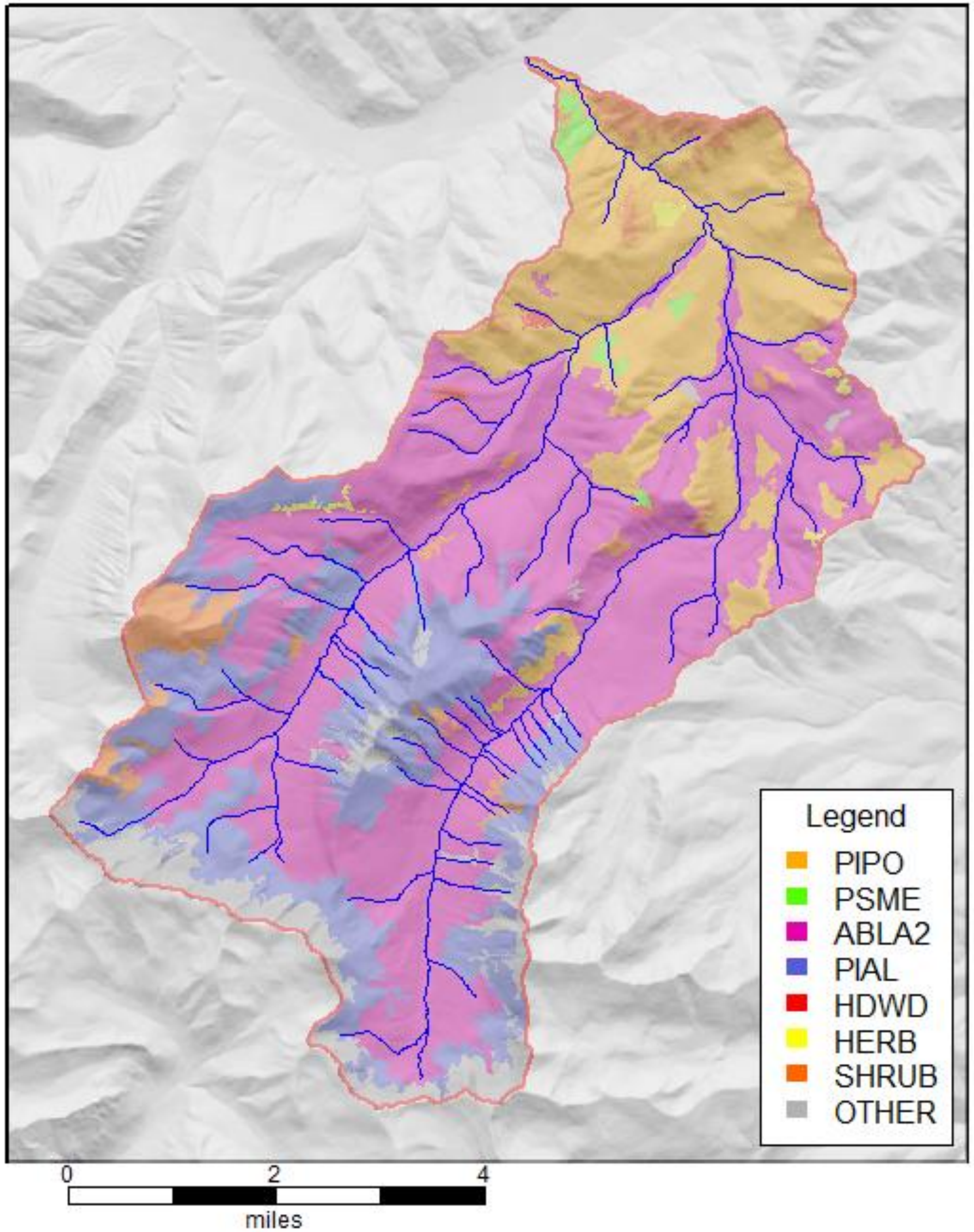


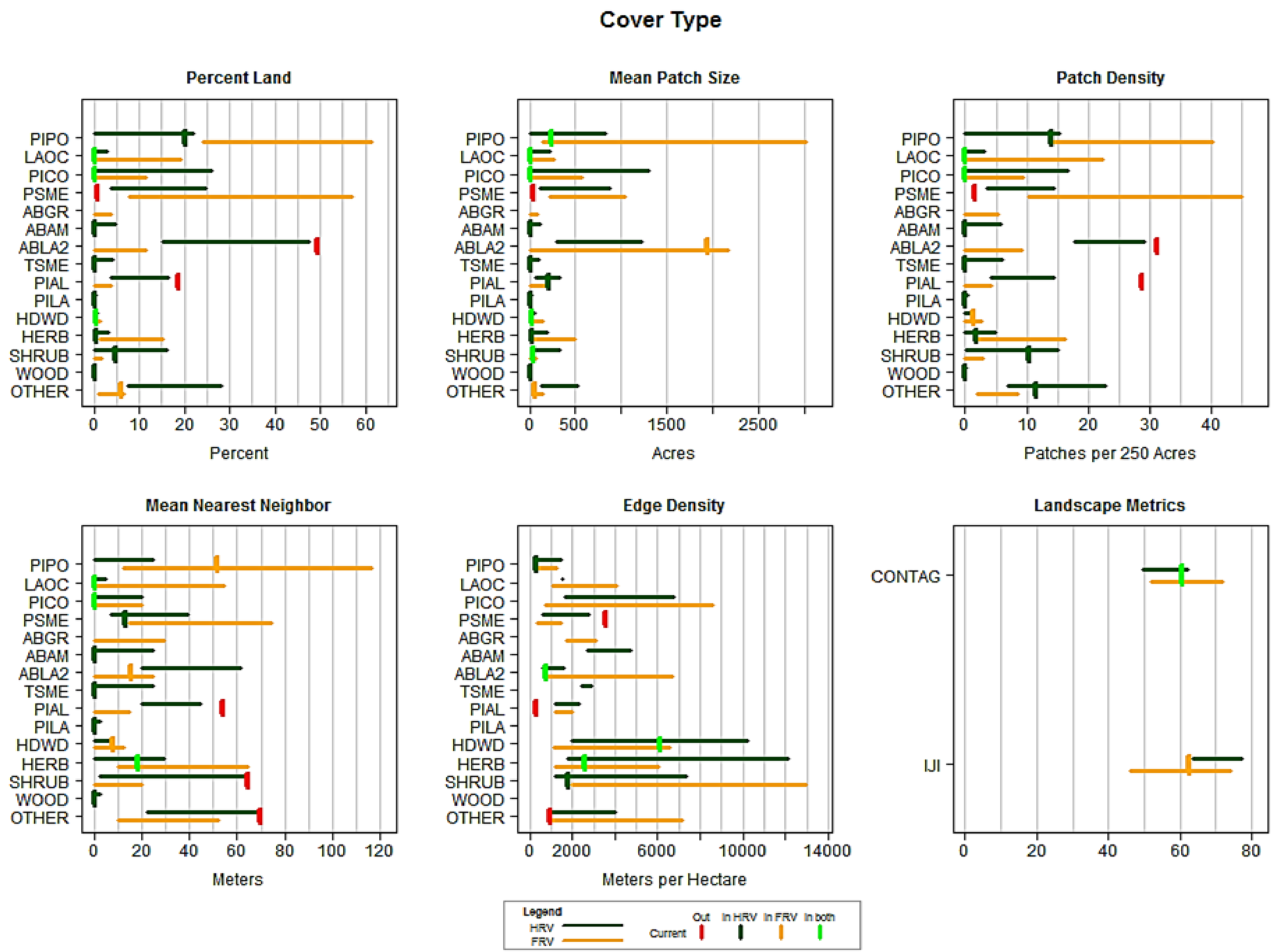
O'Hara et al. 1996.
West. J Appl. For. 11: 97-102



Struct. Class
Percent Land
Mean Patch Size
Patch Density
si
seoc
secc
ur
yfms
ofms
ofss
herb
shrub
wood
other
0 10 20 30 40 50 60
Percent
0 500 1000 1500
Acres
Patches per 250 Acres
Mean Nearest Neighbor
Edge Density
Landscape Metrics
0 50 100 150
Meters
0 5000 10000 15000
Meters per Hectare
CONTAG
IJI
0 20 40 60 80
Legend
HRV
FRV
Current
Out
In HRV
In FRV
In both

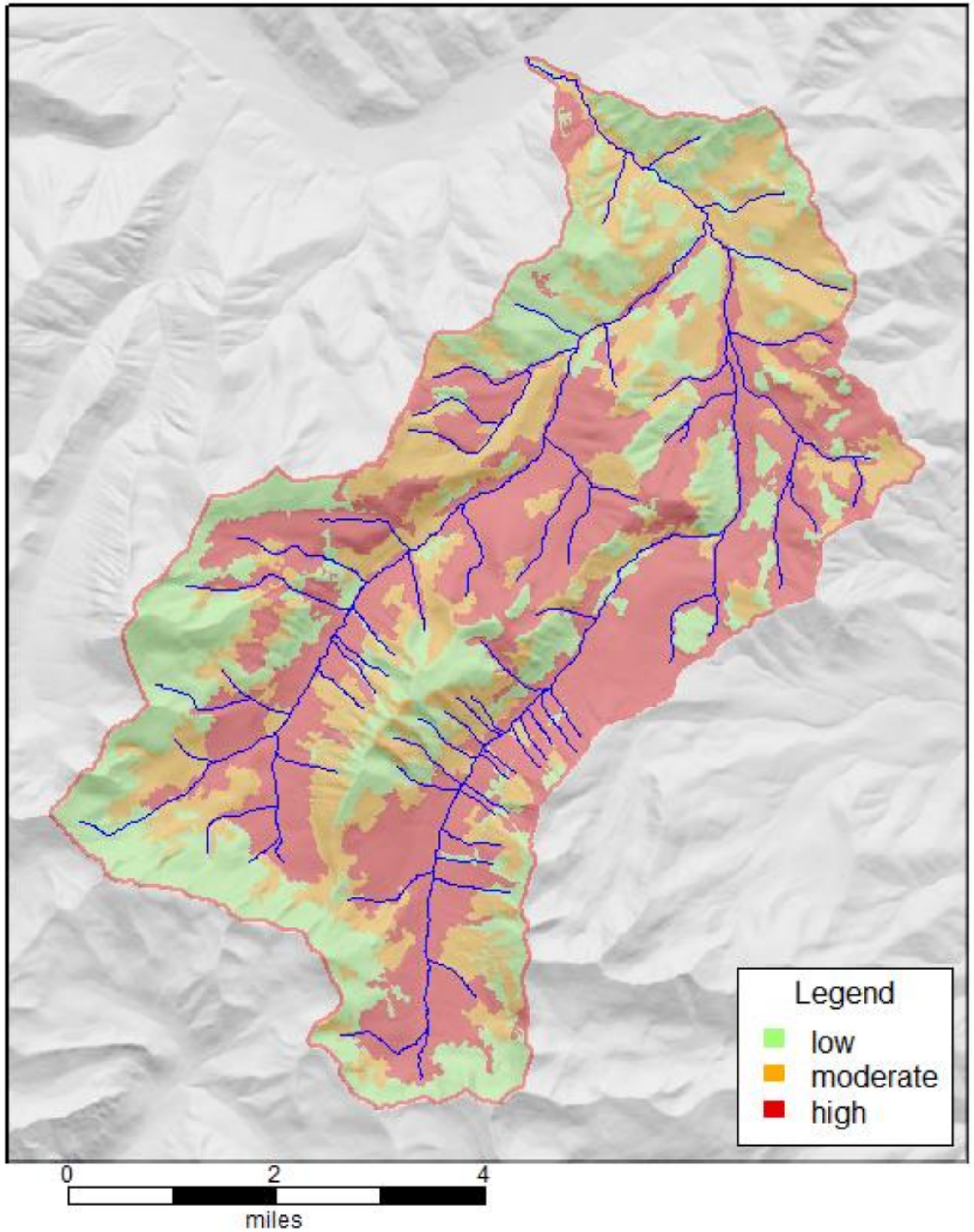
Cover Type



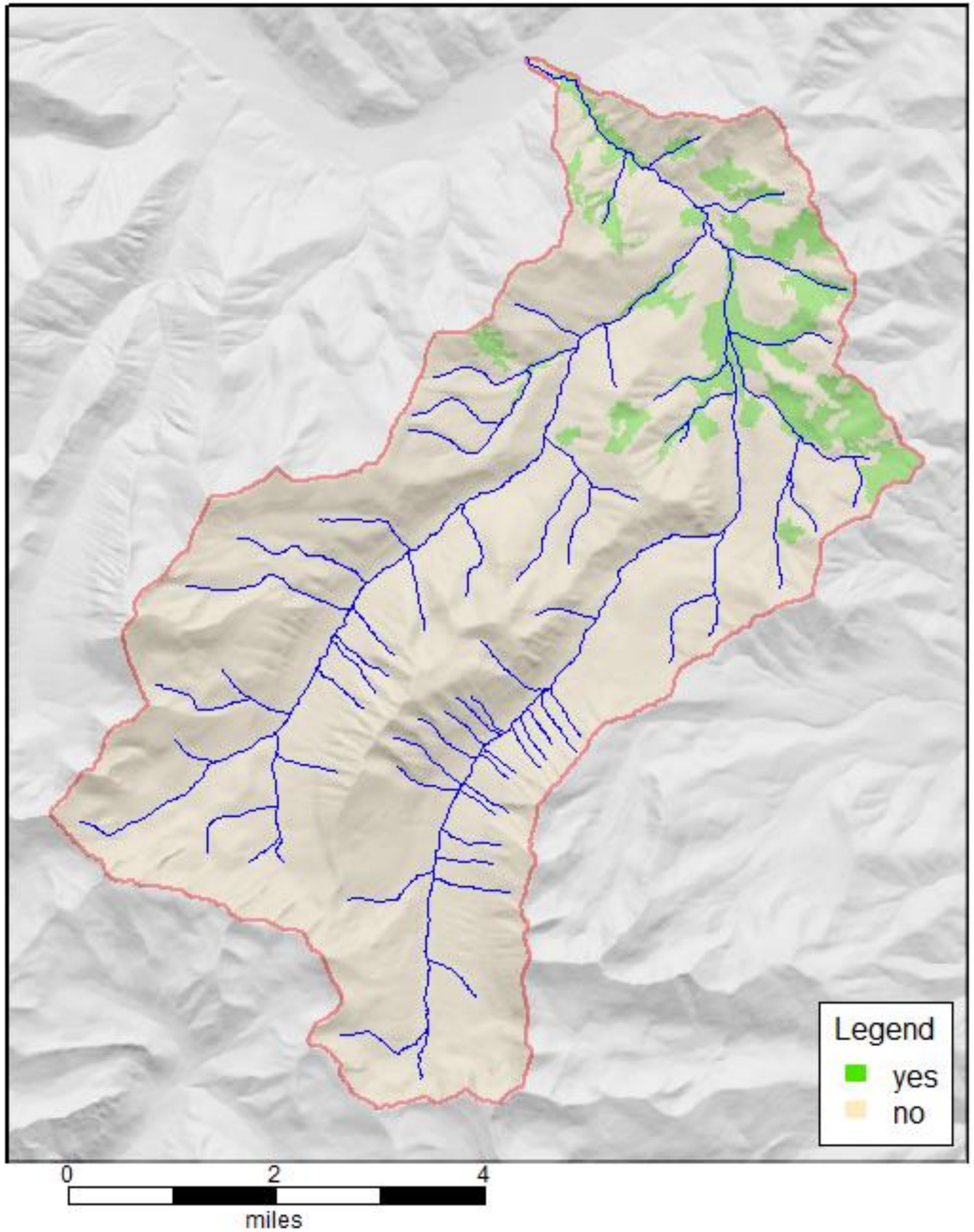


Cover Type
Percent Land
Mean Patch Size
Patch Density
PIPO
LAOC
PICO
PSME
ABGR
ABAM
ABLA2
TSME
PIAL
PILA
HDWD
HERB
SHRUB
WOOD
OTHER
0 10 20 30 40 50 60
Percent
0 500 1500 2500
Acres
0 10 20 30 40
Patches per 250 Acres
Mean Nearest Neighbor
Edge Density
Landscape Metrics
0 20 40 60 80 100 120
Meters
0 2000 6000 10000 14000
Meters per Hectare
CONTAG
IJI
0 20 40 60 80
Legend
HRV
FRV
Current
Out
In HRV
In FRV
In both

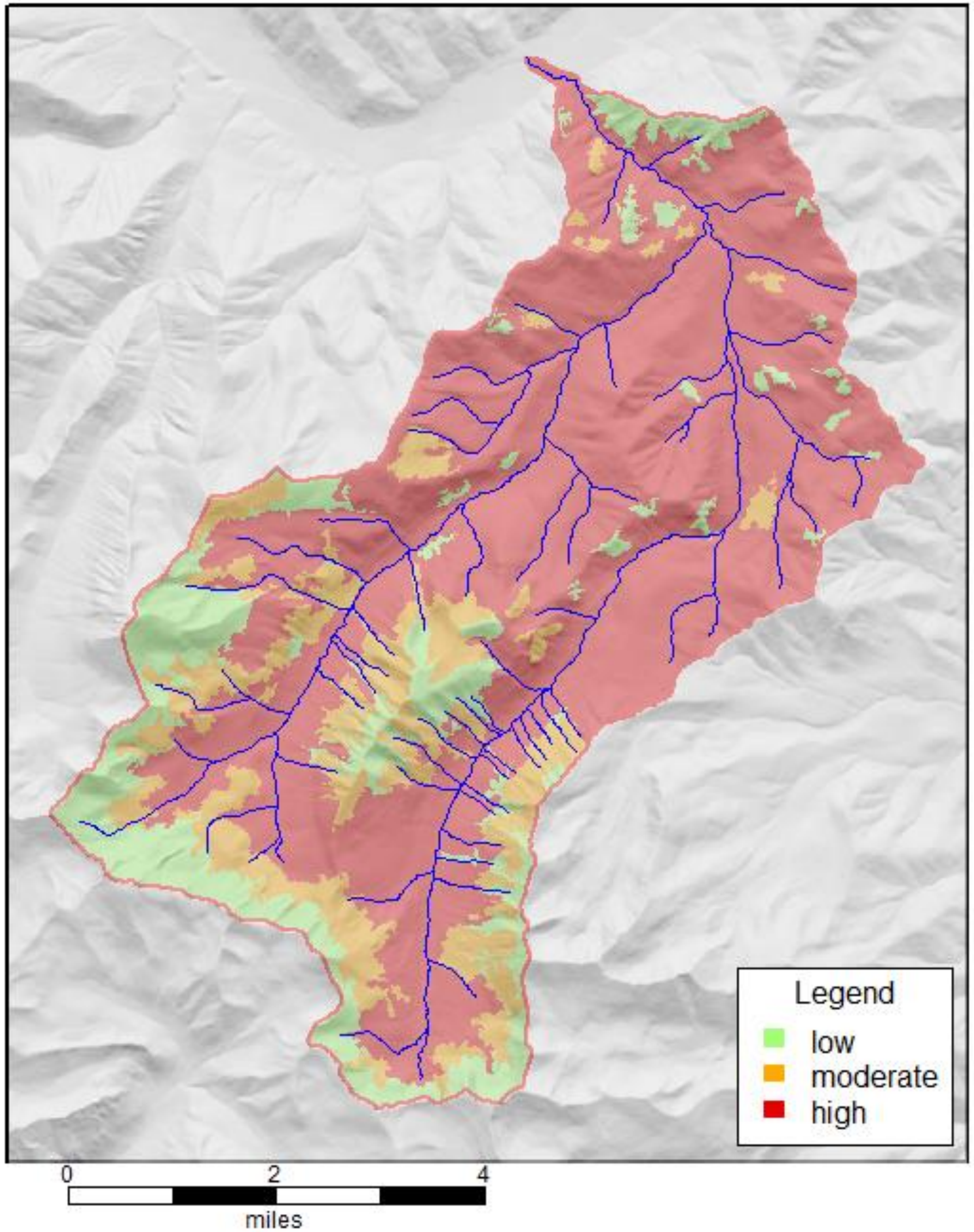
Crown Fire Potential

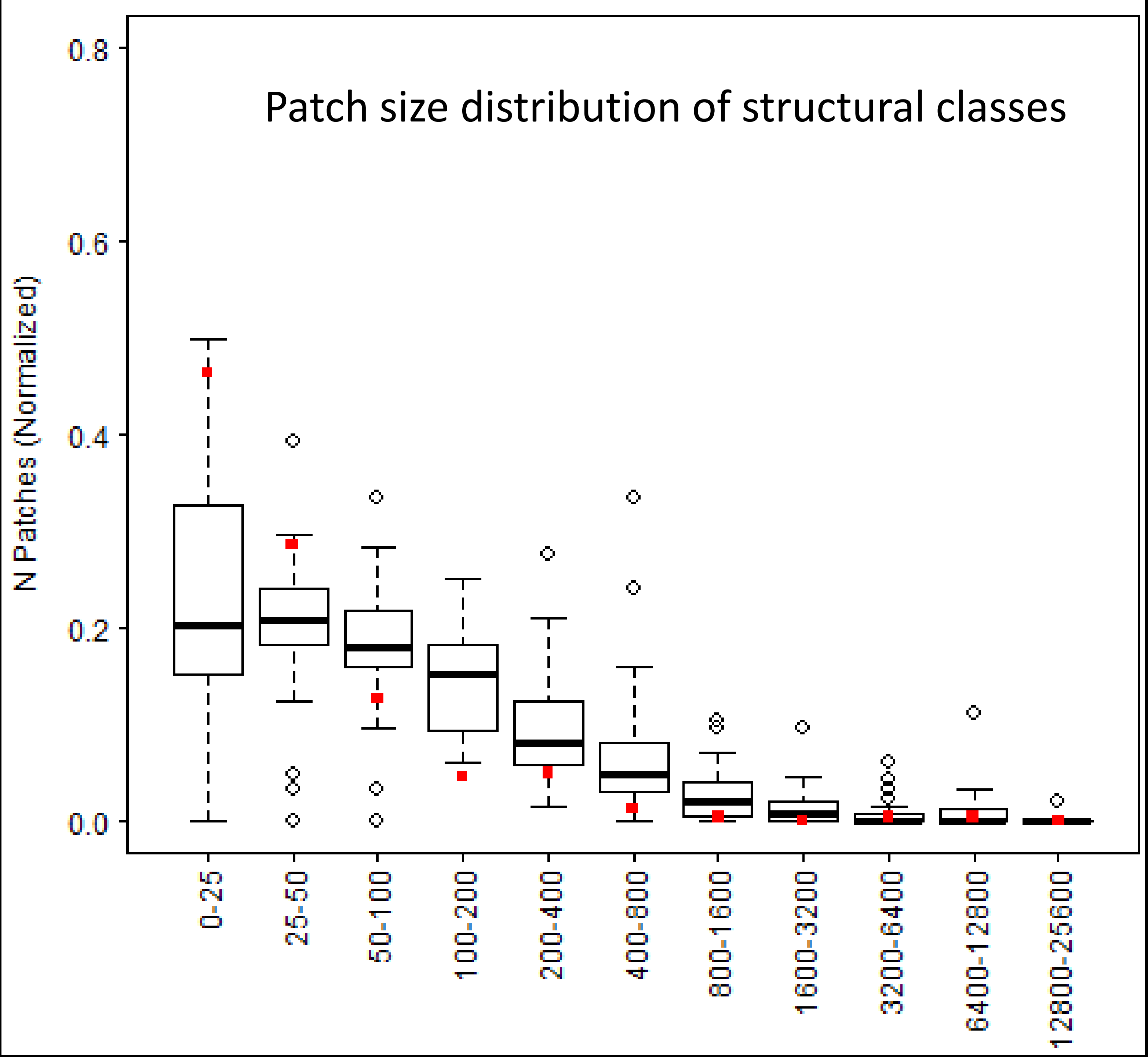


NSO



W. Spruce Budworm





Patch size distribution of structural classes
N Patches (Normalized)
0.0
0.2
0.4
0.6
0.8
0-25
25-50
50-100
100-200
200-400
400-800
800-1600
1600-3200
3200-6400
6400-12800
12800-25600

Landscape Diagnosis

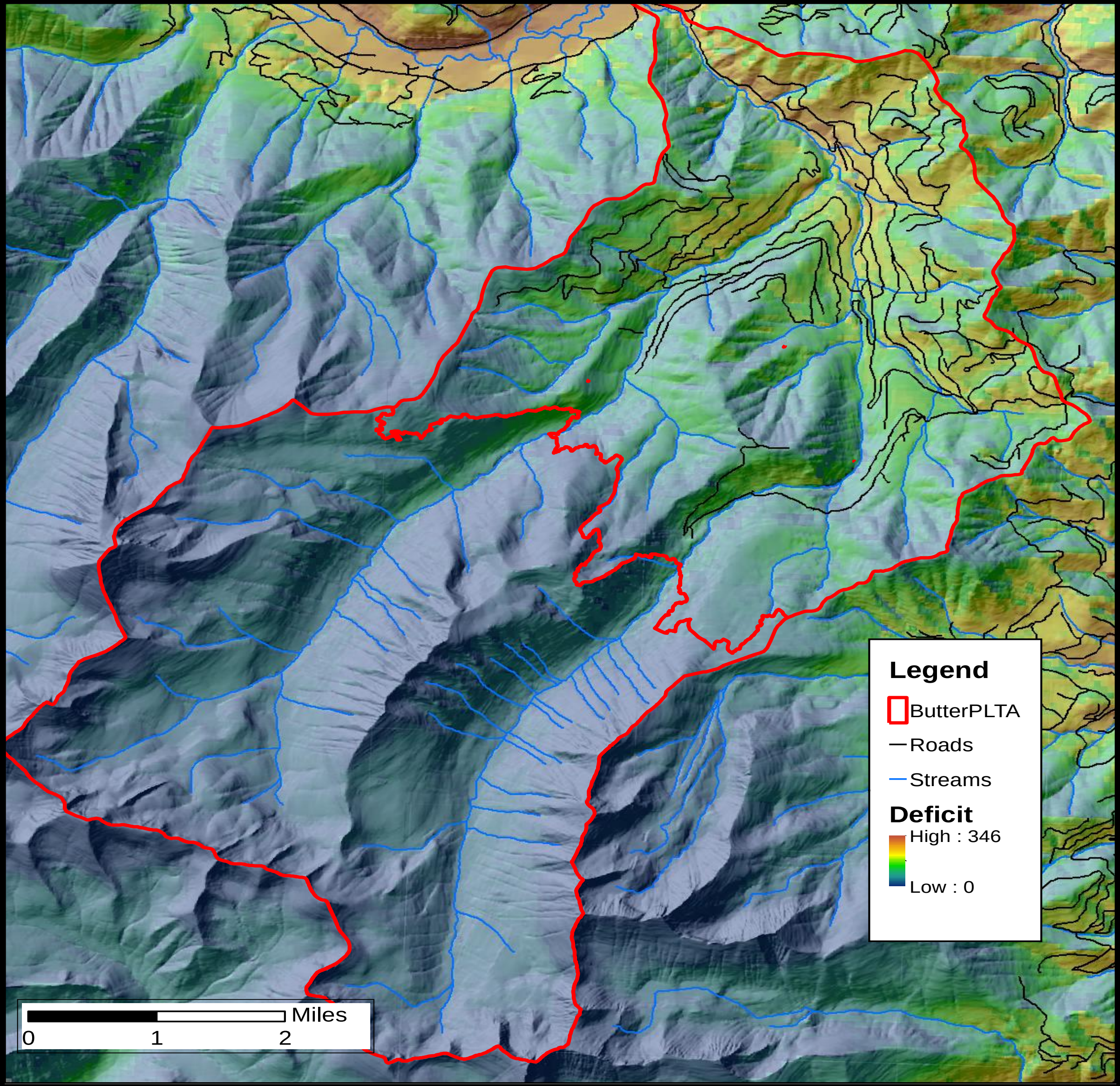
- Too much Young Forest Multi-story ➔ High crown fire potential
- Not enough open canopy forest.
- Patches sizes too small & fragmented
- Too much ABLA2, need more PSME, LAOC, & PICO
- NSO, Large trees ➔ Area ok, pattern not tied to valley bottoms and N aspects

Landscape Rx: A portfolio of treatments

- More area & larger patch sizes of open canopy, large tree forest
- Reduce young multi-story forest on south slopes and ridge tops
- Consolidate large tree, closed, multi-story into larger patches on N aspects and in valley bottoms
- Create larger patches, lower patch density
- Tailor patches to the topography

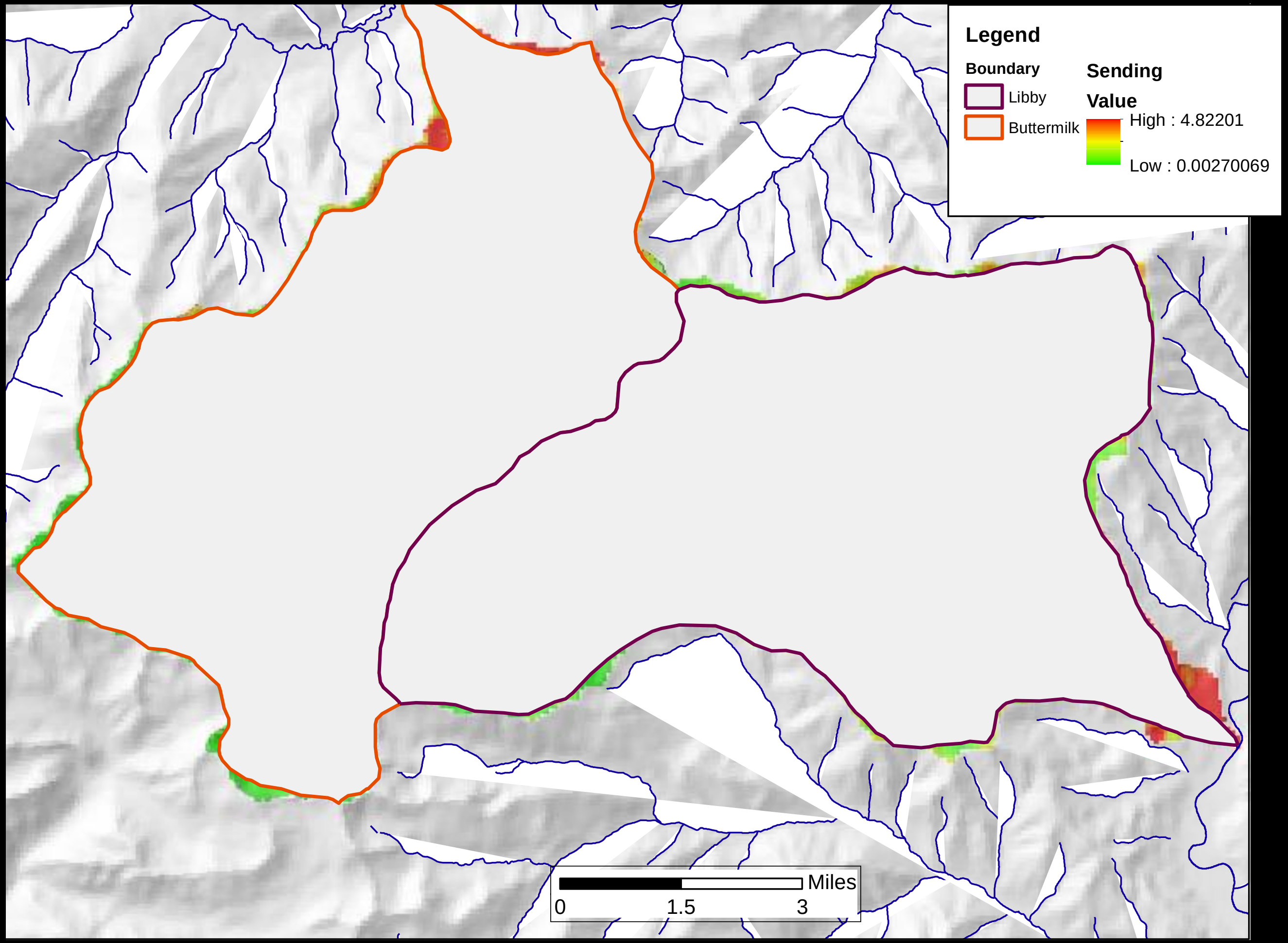
Landscape Rx >> Treatment Recommendations

Using predicted water balance deficit (PET-AET) patterns to tailor Rx's to topography



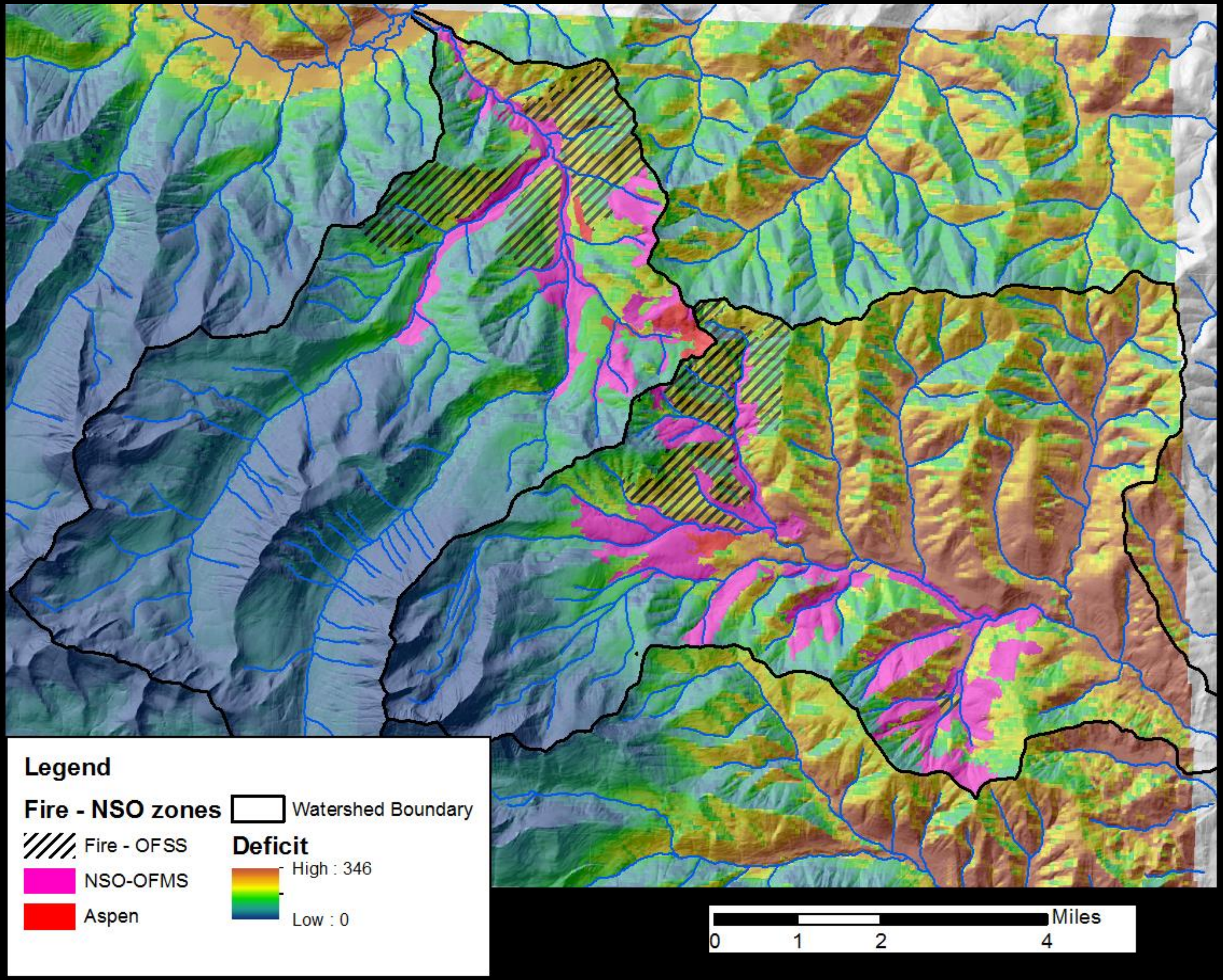
FlamMap: Wildfire "sending" Index

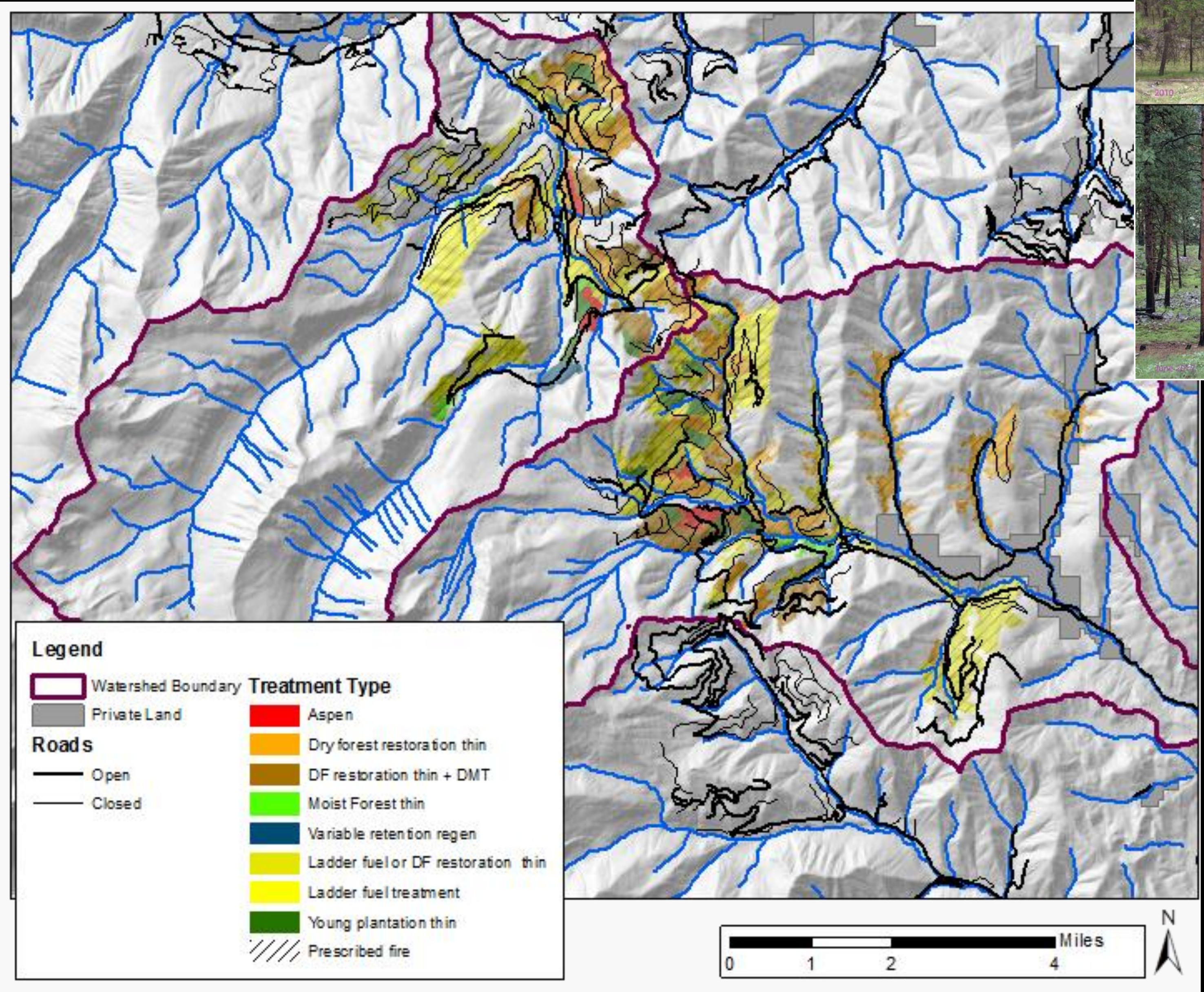
We can ID areas that have a high propensity to send severe wildfire to the many other areas given prevailing winds, slopes, and fuels

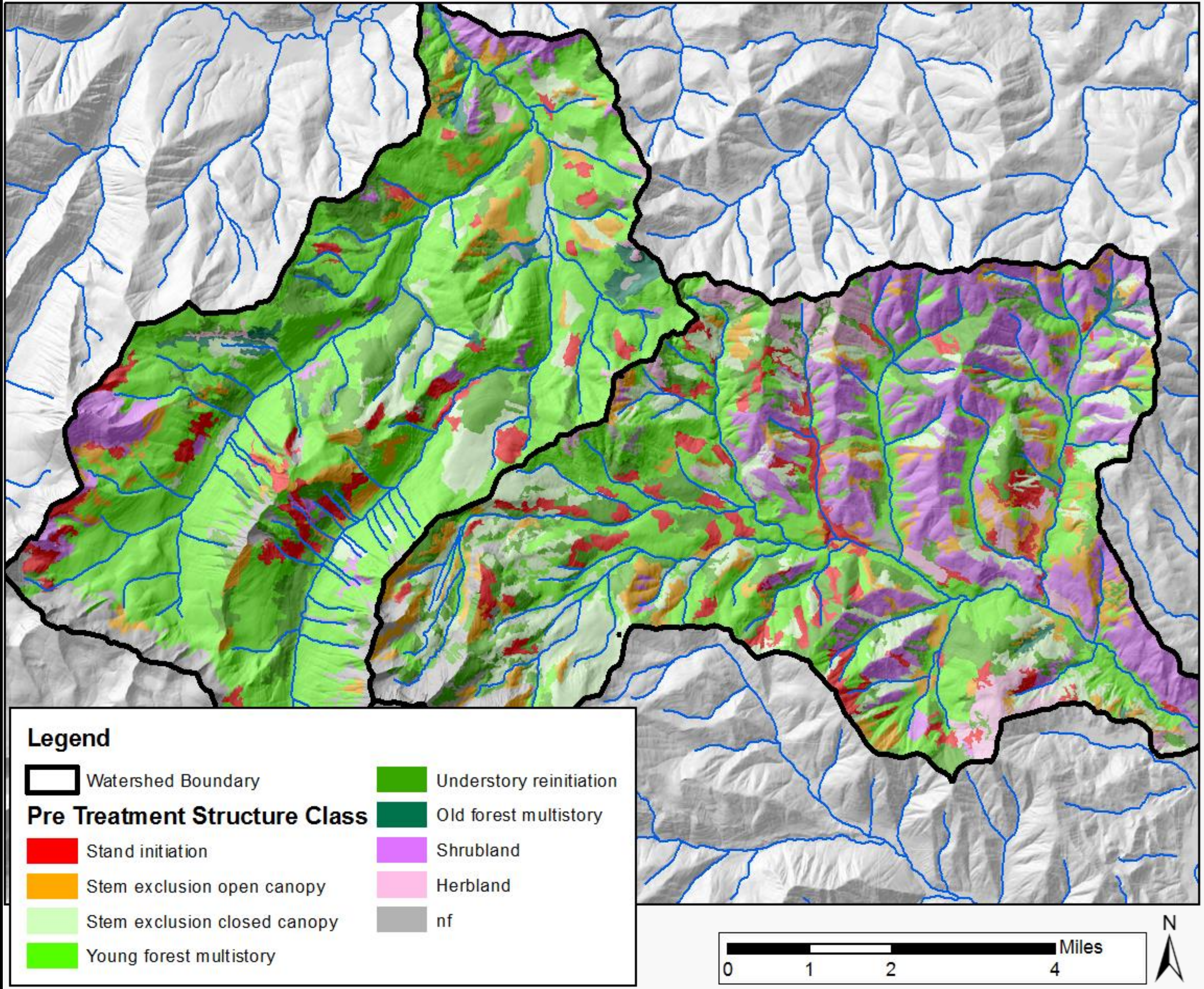


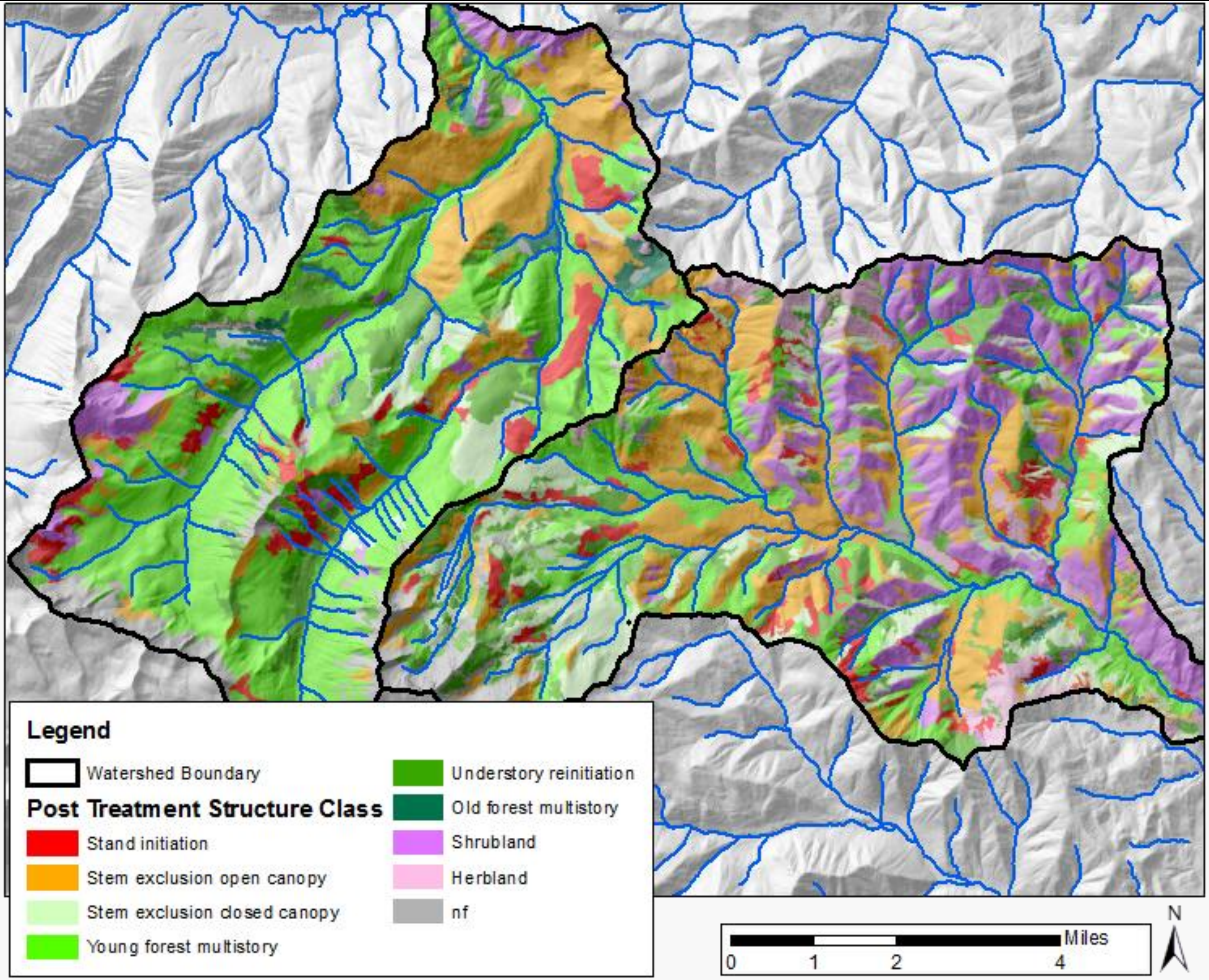
Identifying NSO preferred habitat locations

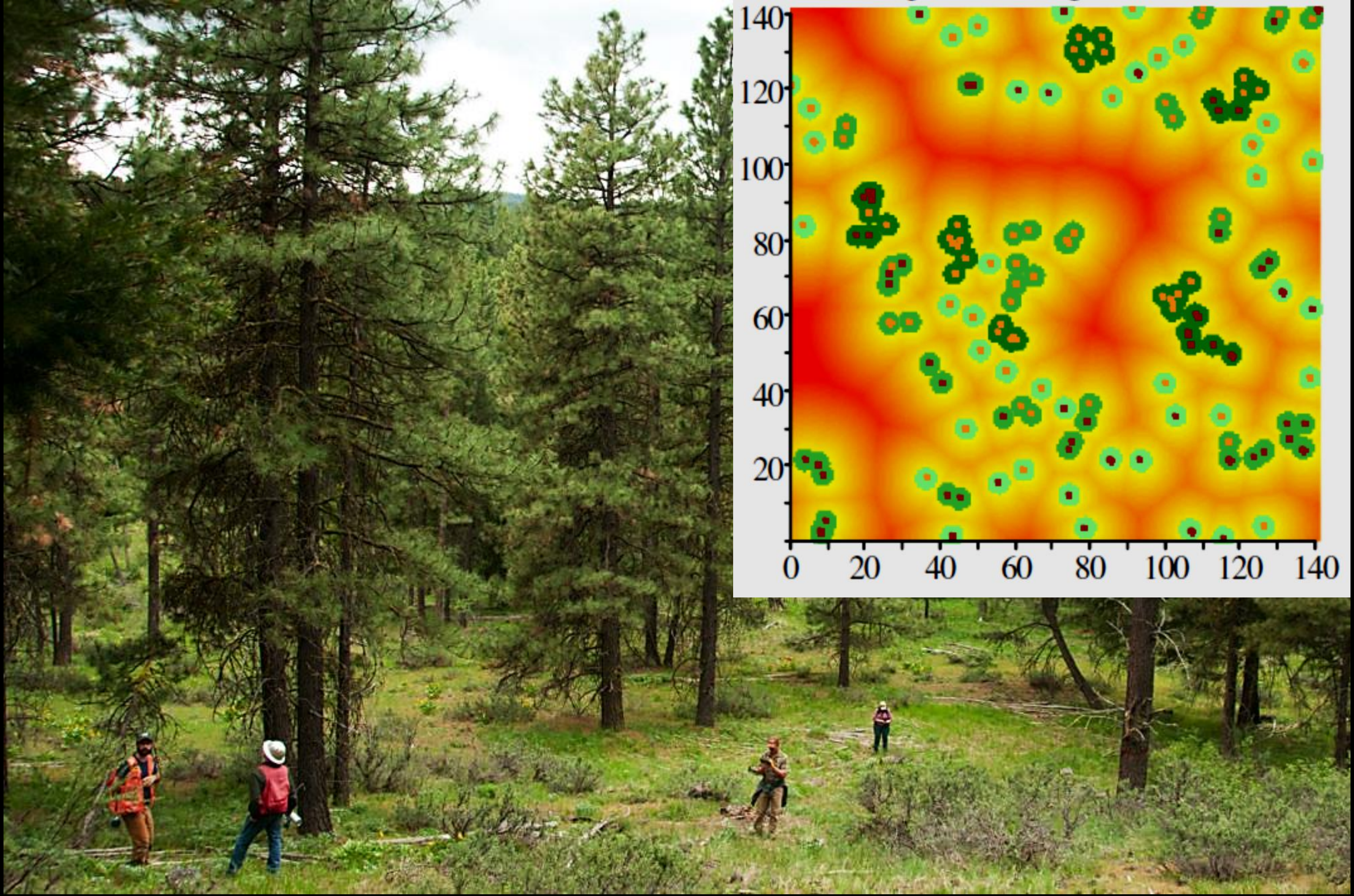
Using low water deficit locations, N aspects and valley bottoms to situate them




Legend
Watershed Boundary
Private Land
Roads
Open
Closed
Treatment Type
Aspen
Dry forest restoration thin
DF restoration thin + DMT
Moist Forest thin
Variable retention regen
Ladder fuel or DF restoration thin
Ladder fuel treatment
Young plantation thin
Prescribed fire
Miles
0
1
2
4
N


Legend
Watershed Boundary
Pre Treatment Structure Class
Stand initiation
Stem exclusion open canopy
Stem exclusion closed canopy
Young forest multistory
Understory reinitiation
Old forest multistory
Shrubland
Herbland
nf
Miles
0 1 2 4
N


Legend
Watershed Boundary
Post Treatment Structure Class
Stand initiation
Stem exclusion open canopy
Stem exclusion closed canopy
Young forest multistory
Understory reinitiation
Old forest multistory
Shrubland
Herbland
nf
0 1 2 4 Miles
N



Tree Neighborhoods / Silv. Rx

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Restoring forest resilience: From reference spatial patterns to silvicultural prescriptions and monitoring

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The ICO Approach to Quantifying and Restoring Forest Spatial Pattern

Implementation Guide

Version 3 - May 2016

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Article

Landscape Evaluation for Restoration Planning on the Okanogan-Wenatchee National Forest, USA

Paul F. Hessburg [1,*], Keith M. Reynolds [2], R. Brion Salter [1], James D. Dickinson [3], William L. Gaines [3] and Richy J. Harrod [3]

Questions?

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