Fire refugia in late-successional forests

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Forest Health in Oregon: State of the State | 3.1.18

Table Mountain Fire, WA, 2012 (2013)

Fire refugia context

- Fire mosaics have key implications for biodiversity and ecosystem services.
- Widespread concerns about increasing fire activity, particularly high-severity fire.
- Increasing interest in **fire refugia** among researchers, managers, and policy makers.
- **Working definition**: places that burn less frequently or severely than the surrounding landscape (Krawchuk et al. 2016).

Pole Creek Fire, OR, 2012 (2013)

Fire refugia definition

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Global change context:

- Fire refugia are a subset of broader refugia.

- Refugia provide protection *for something, from something.*

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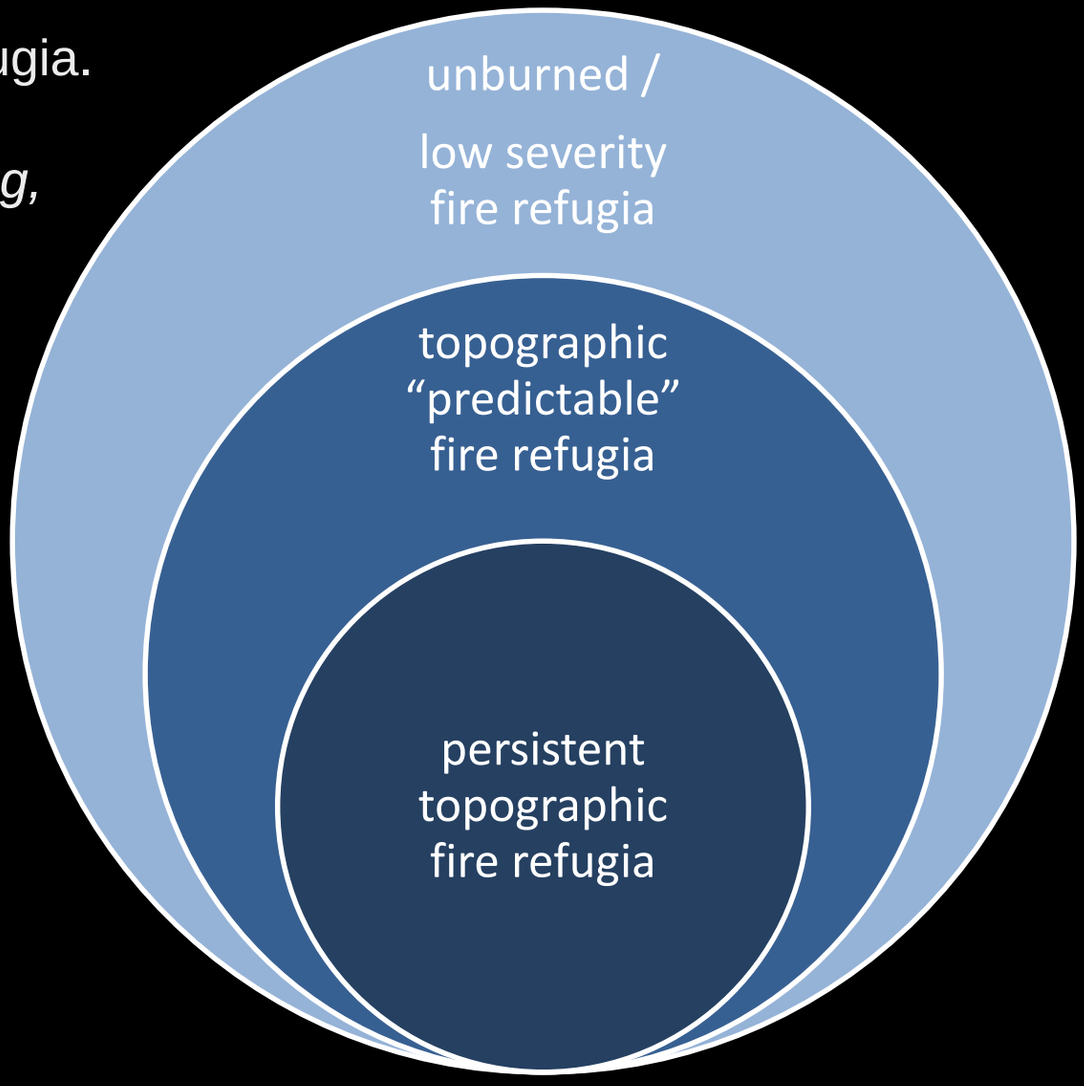
Key aspects:

- Predictability
- Persistence



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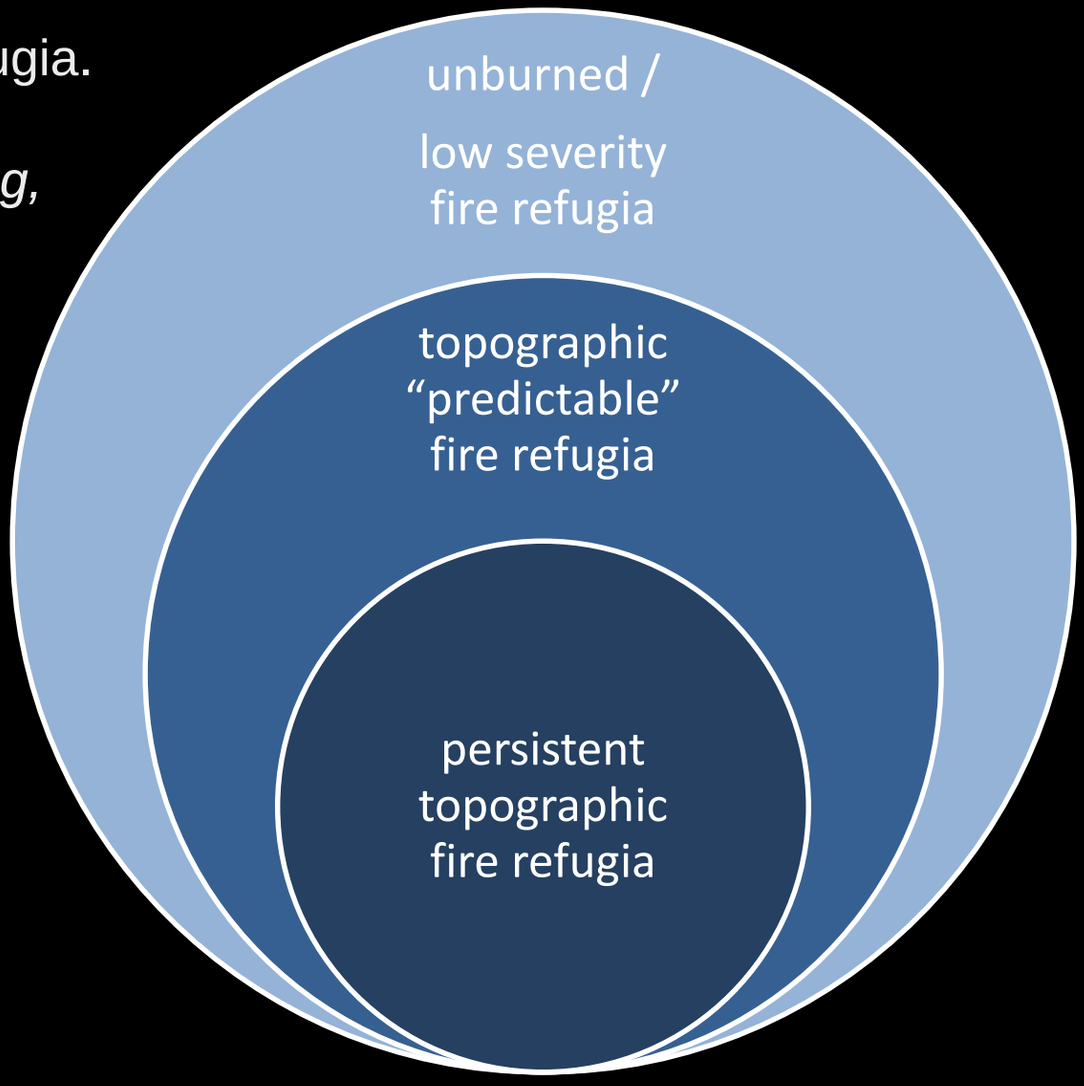
- Persistence
- Scale: species vs. landscape pattern



Fire refugia mapping

- Landsat: go-to satellite for mapping fire effects
- (R)dNBR: go-to metric to assess change from pre- to post-fire
- Monitoring Trends in Burn Severity (MTBS): go-to source
- Pre-fire composition and structure are critical

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Quantifying burn severity in a heterogeneous landscape with a relative version of the delta Normalized Burn Ratio (dNBR)

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[b] School of Forestry, Northern Arizona University, P.O. Box 15018, Flagstaff, Arizona 86011, United States

Received 16 June 2006; received in revised form 6 November 2006; accepted 8 December 2006

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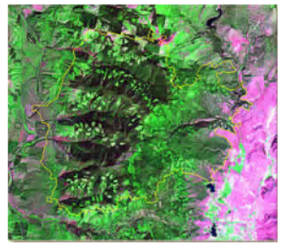
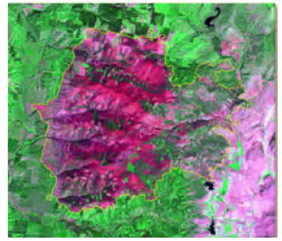
Prefire Image



Prefire scenes are comprised of Landsat TM/ETM/OLI data and are selected to match the seasonality and phenology of the postfire image chosen. This layer is clipped to a 3km-buffered bounding box around the burn area boundary.

File Format: GeoTiff
File name: <Fire ID>_<prefire image date>_<sensor>_refl.tif

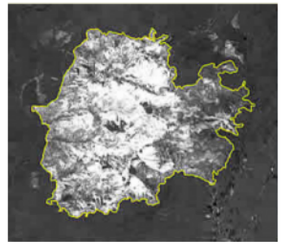
Postfire Image



Postfire scenes are comprised of Landsat TM/ETM/OLI data and are selected for either an initial or extended assessment for mapping. The assessment type chosen is dependent on the affected ecosystem and its response to fire. This layer is clipped to a 3km-buffered bounding box around the burn area boundary.

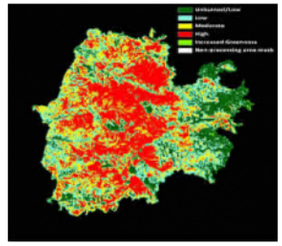
File Format: GeoTiff
File name: <Fire ID>_<postfire image date>_<sensor>_refl.tif

NBR/dNBR/RdNBR Images



NBR, dNBR, and RdNBR images are created for each fire depending if the fire was mapped using a single scene (NBR) or two scene (dNBR/RdNBR) mapping strategy.
File Format: GeoTiff
File name:
<Fire ID>_<postfire image date>_nbr.tif
<Fire ID>_<prefire image date>_<postfire image date>_dnbr.tif
<Fire ID>_<prefire image date>_<postfire image date>_rdnbr.tif

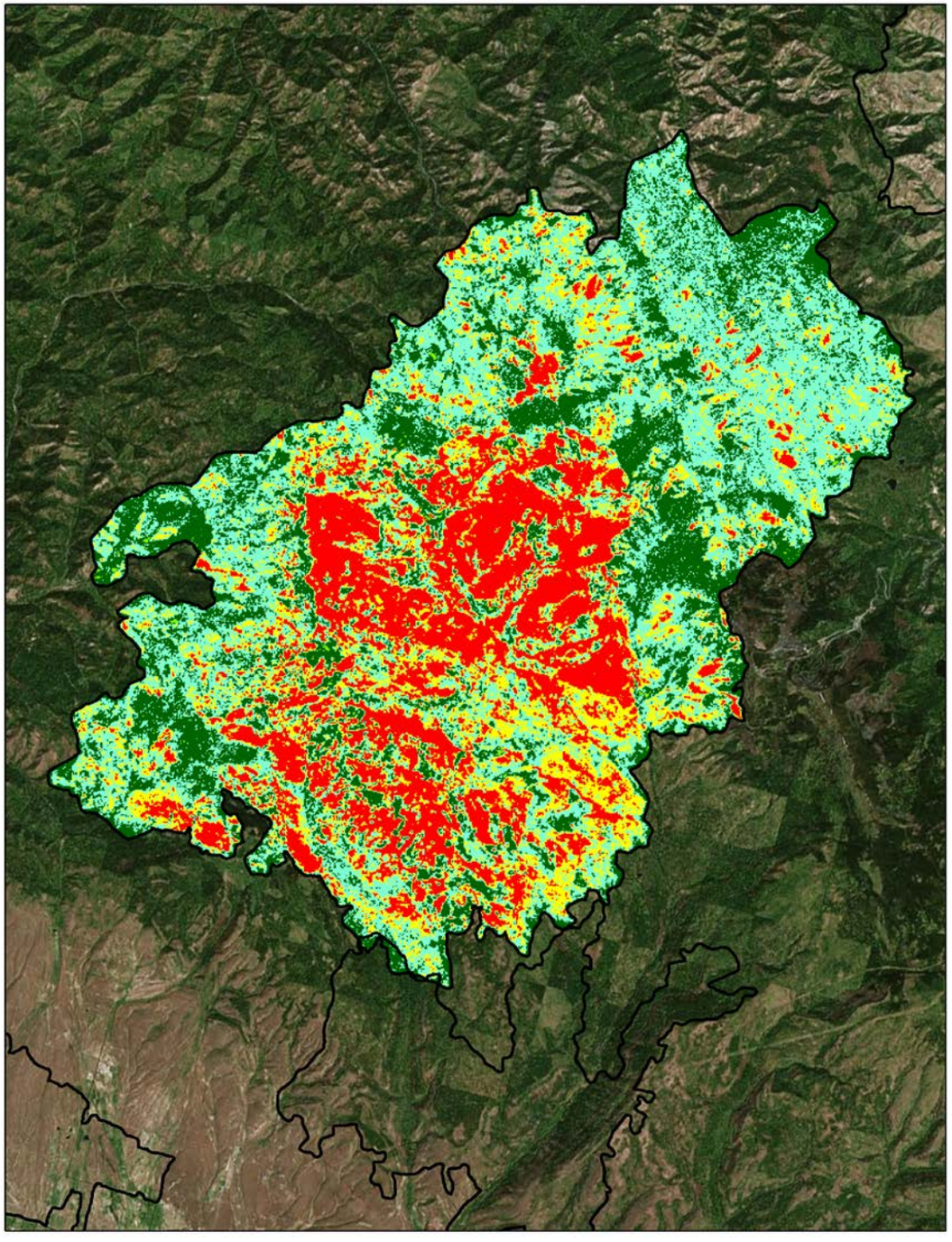
Thematic Burn Severity



Burn severity layers are thematic images depicting severity as unburned to low, low, moderate, high, and increased greenness (increased postfire vegetation response). The layer may also have a sixth class representing a mask for clouds, shadows, large water bodies, or other features on the landscape that erroneously affect the severity classification.

File Format: GeoTiff
File name:
<Fire ID>_<postfire image date>_nbr6.tif
<Fire ID>_<prefire image date>_<postfire image date>_dnbr6.tif

Landscape context: Table Mountain MTBS



Acreage of Burn Severity	
Burn Severity	**Acres**
Unburned to Low	16,081
Low	24,031
Moderate	11,827
High	13,818
Increased Greenness	127
Non-Processing Area Mask*	0
Total	**65,884**

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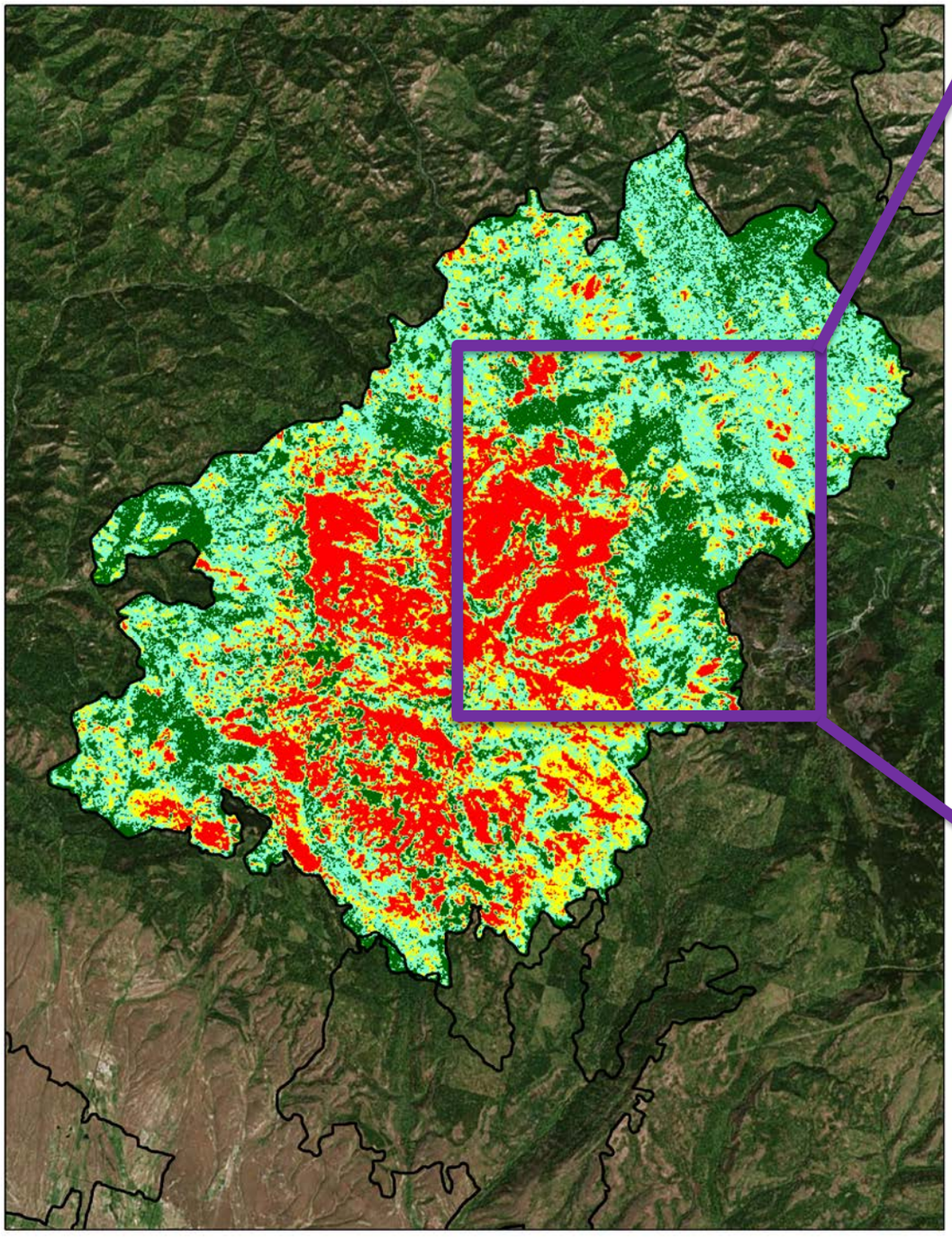

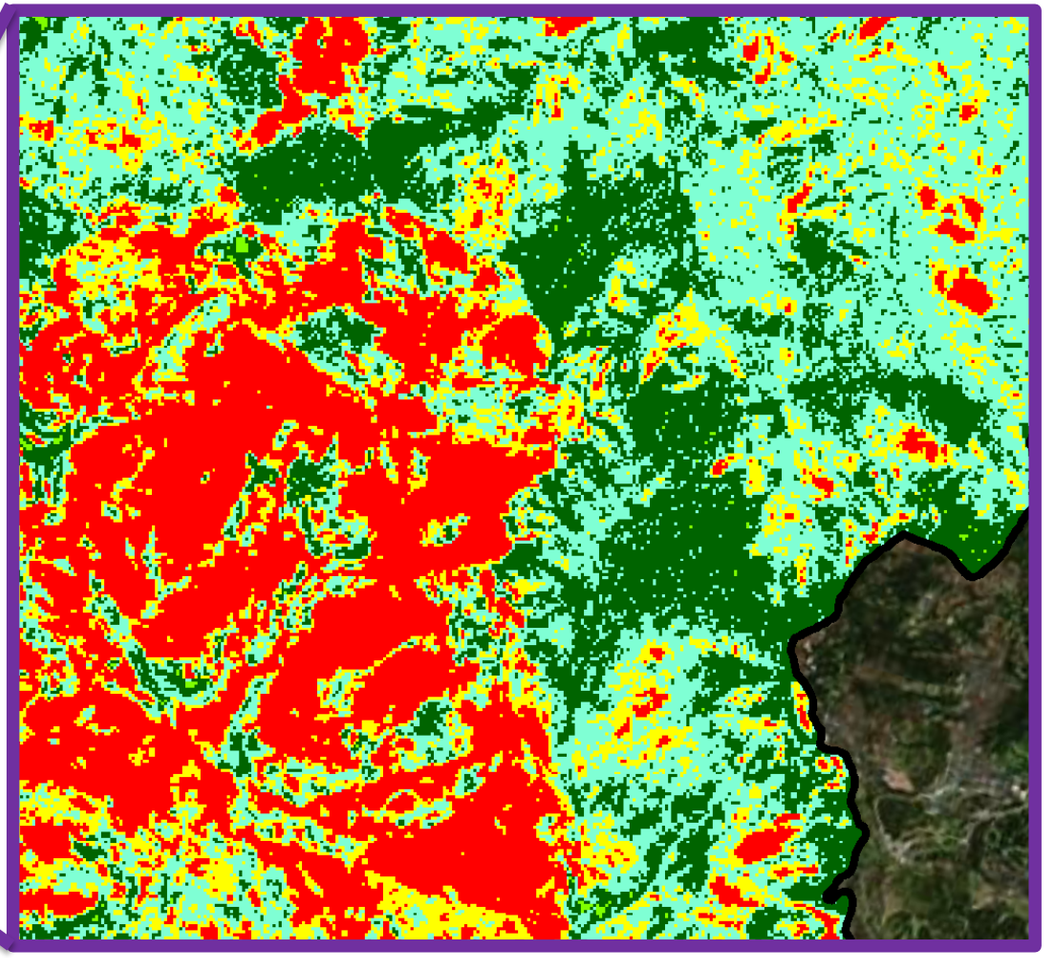

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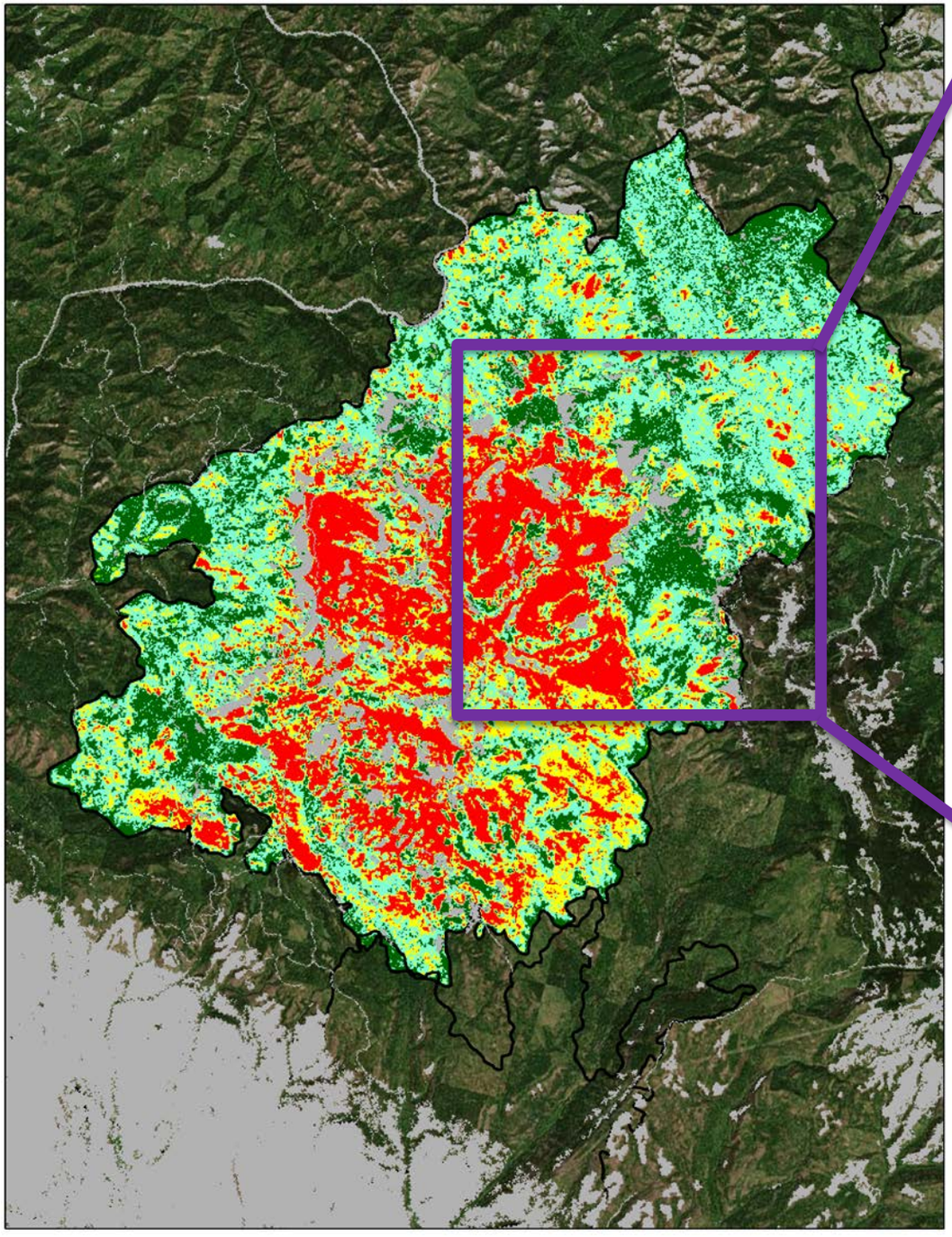
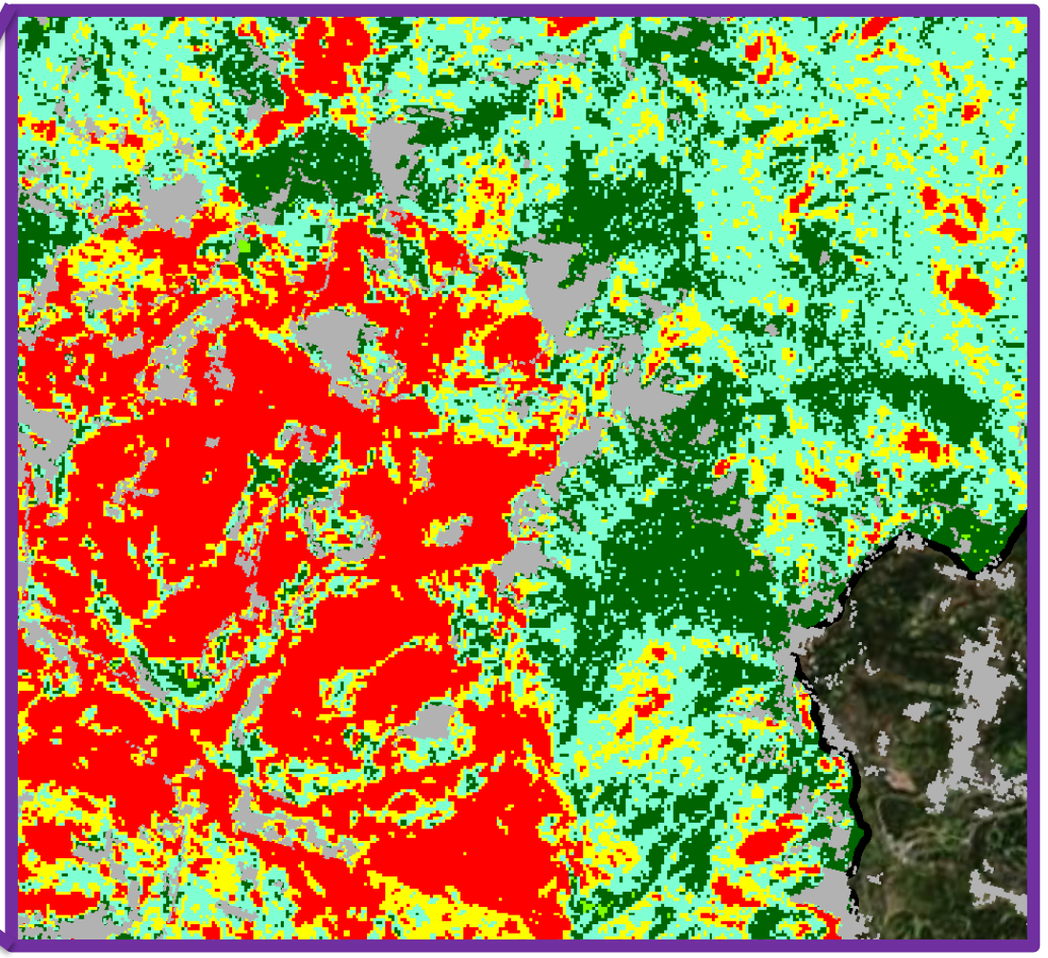
24%

Landscape context: Table Mountain MTBS with forest mask





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Nonforest land cover matters

Table Mountain Fire, 2012 (2013)

Nonforest land cover matters

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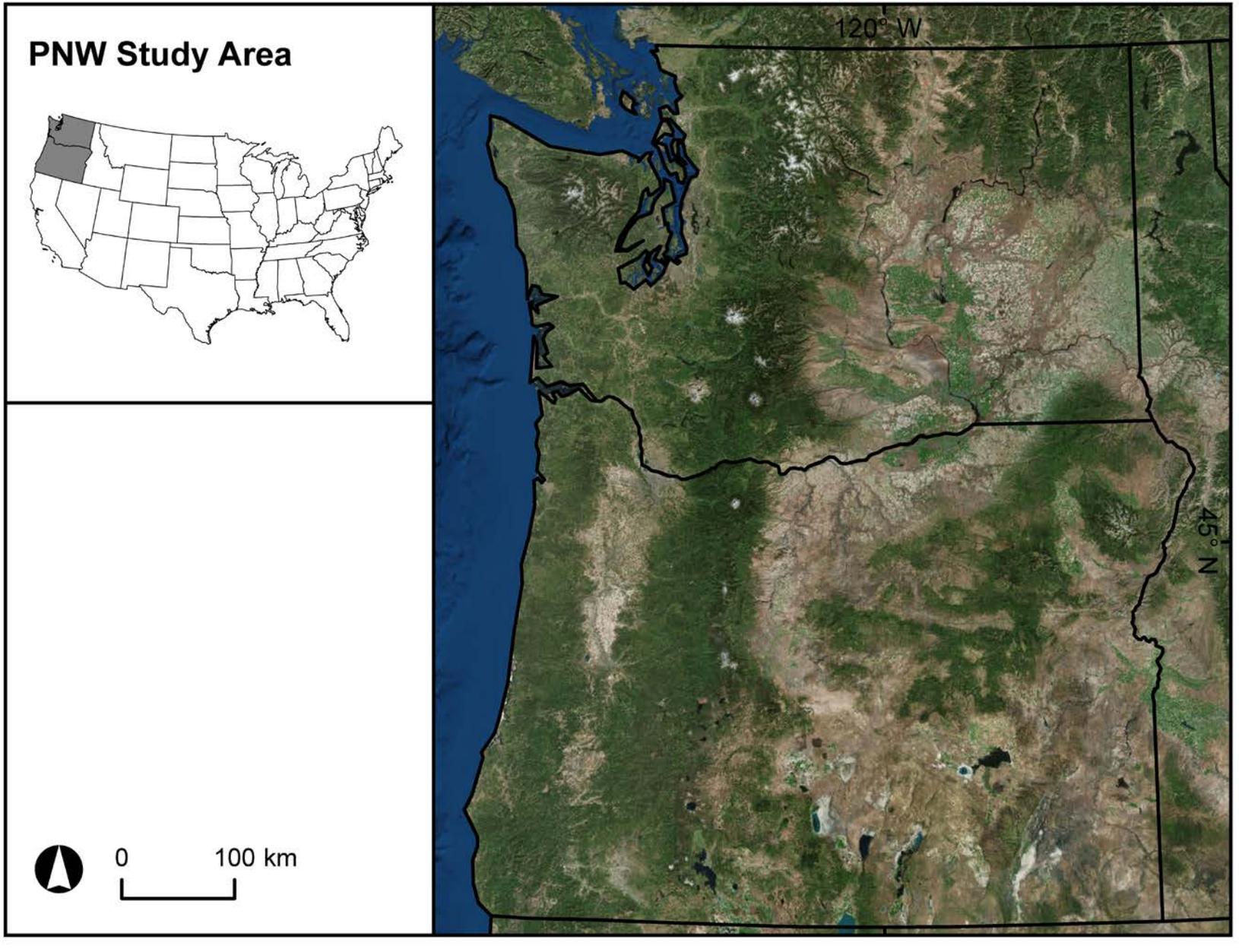
What is the forest composition and structure of refugia?

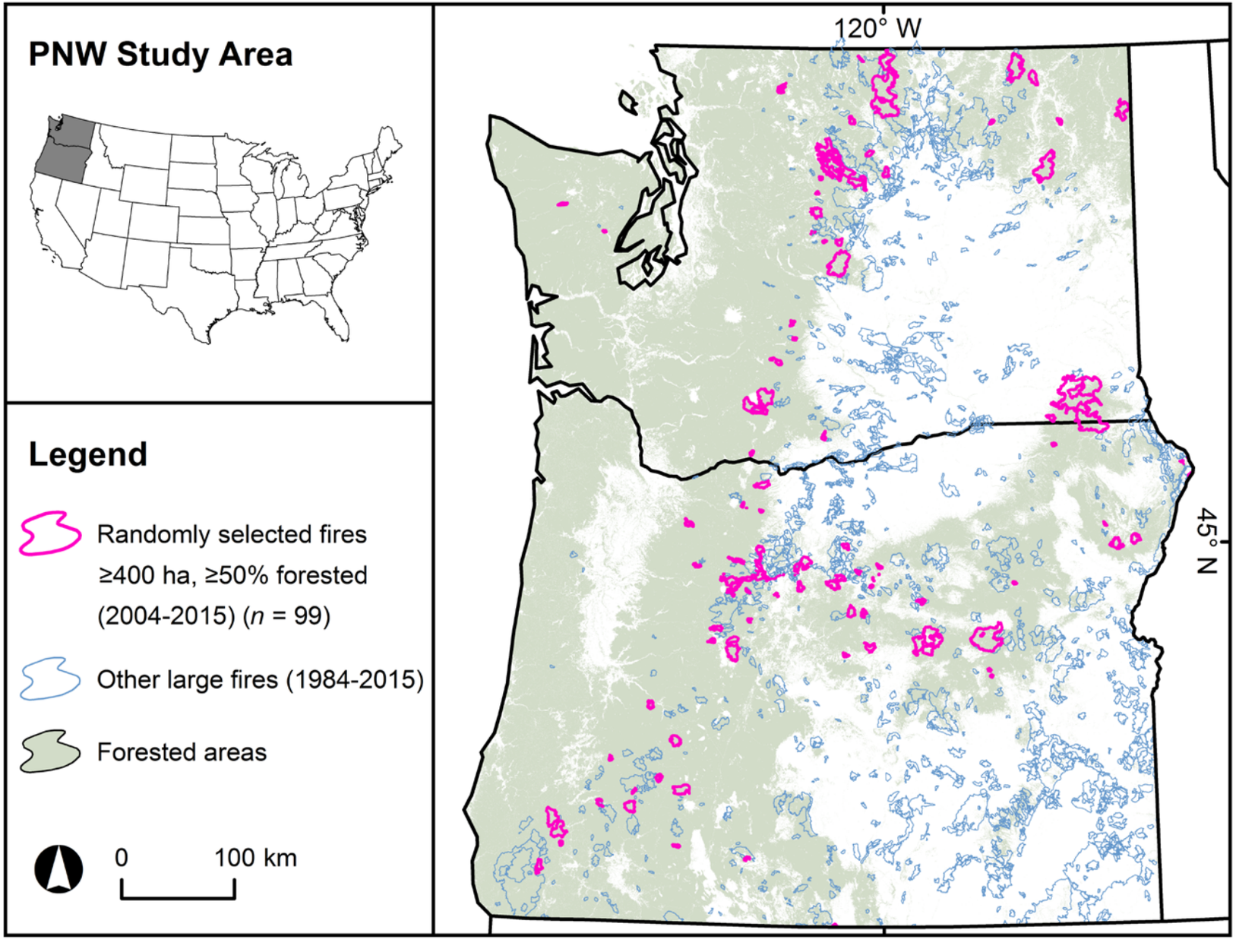
Approach:

- Fire perimeters from Monitoring Trends in Burn Severity (mtbs.gov).
- Landsat imagery from LandTrendr algorithm (Kennedy et al. 2010).
- Severity thresholds from US Forest Service inventory data (Reilly et al. 2017).
  - % change in basal area: 0-10, >10-25, >25-75, >75-90, >90-100
- Pre-fire forest composition and structure based on Gradient Nearest Neighbor maps (GNN; Ohmann et al. 2012).

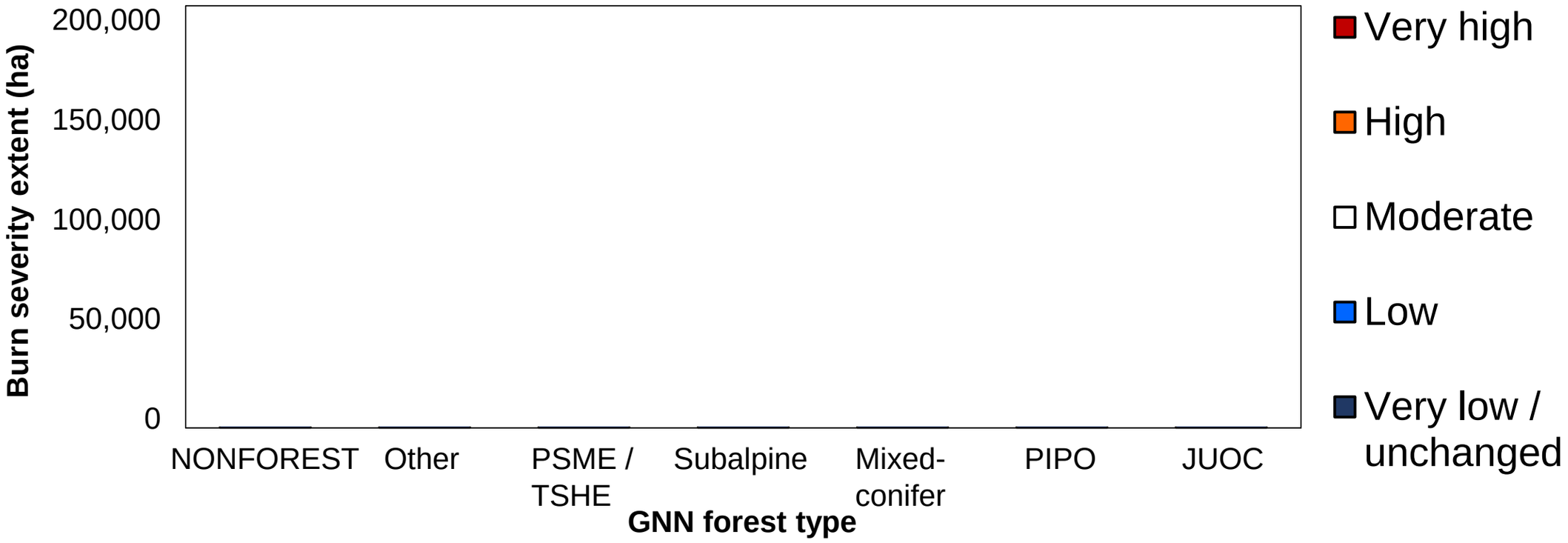
Pacific Northwest study area



Study area and selected fires (*n* = 99)



Some forest types have more refugia than others



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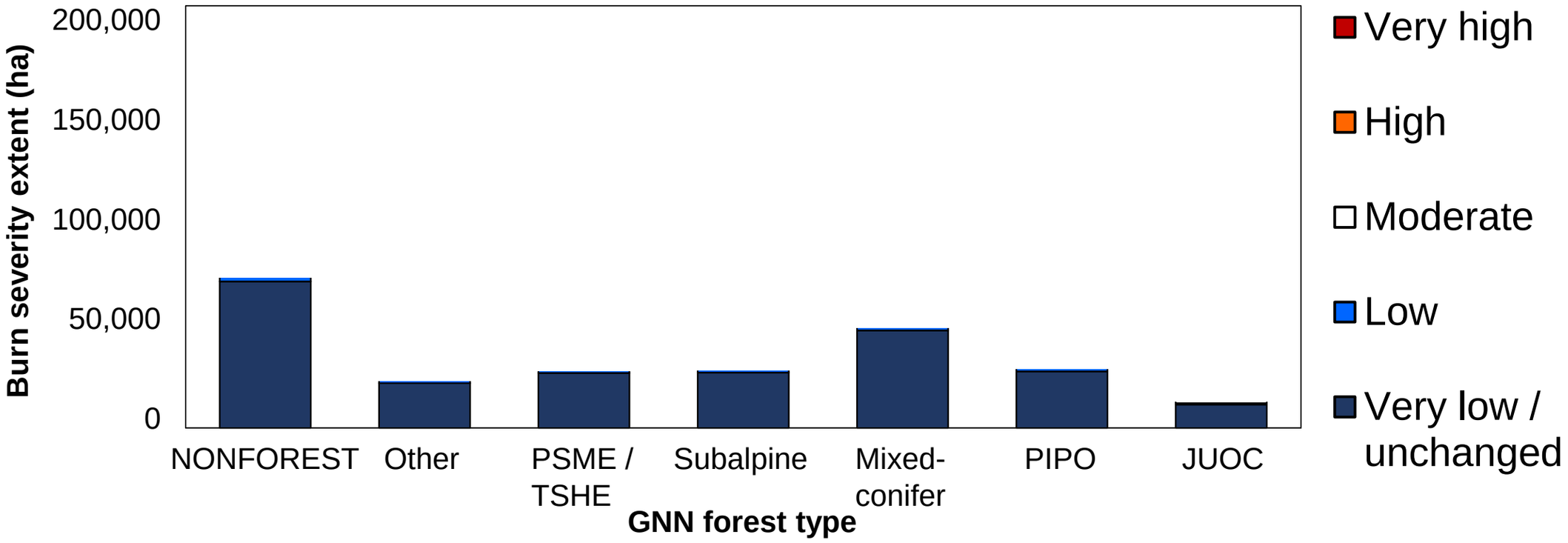

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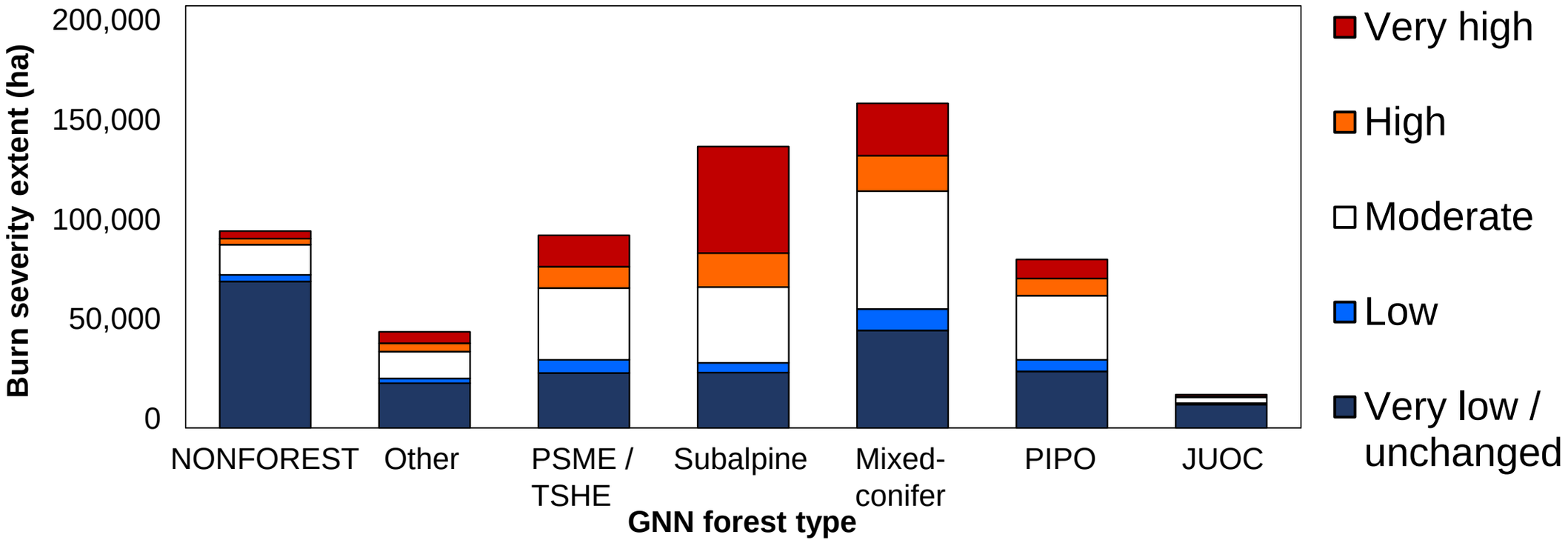

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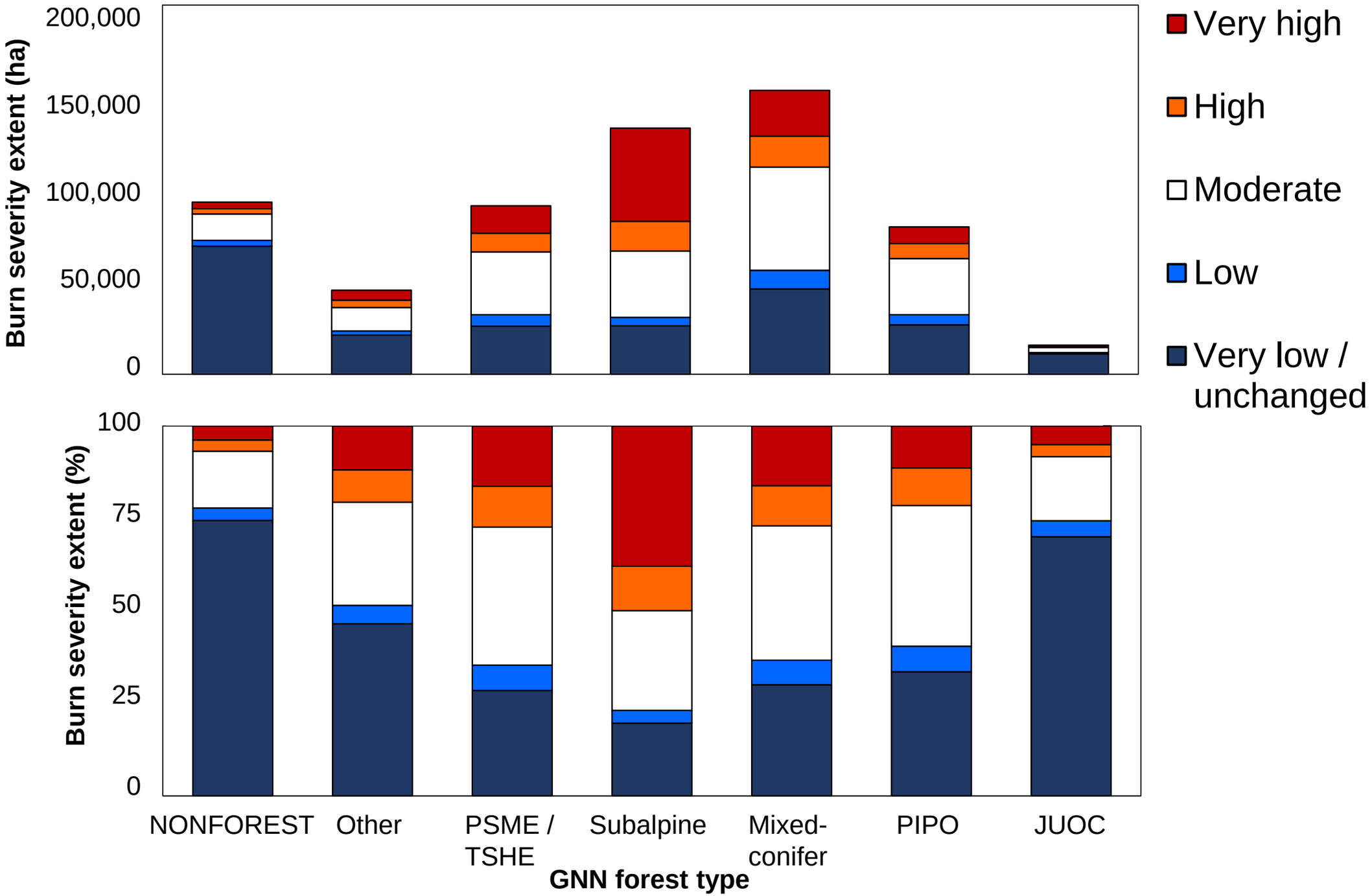

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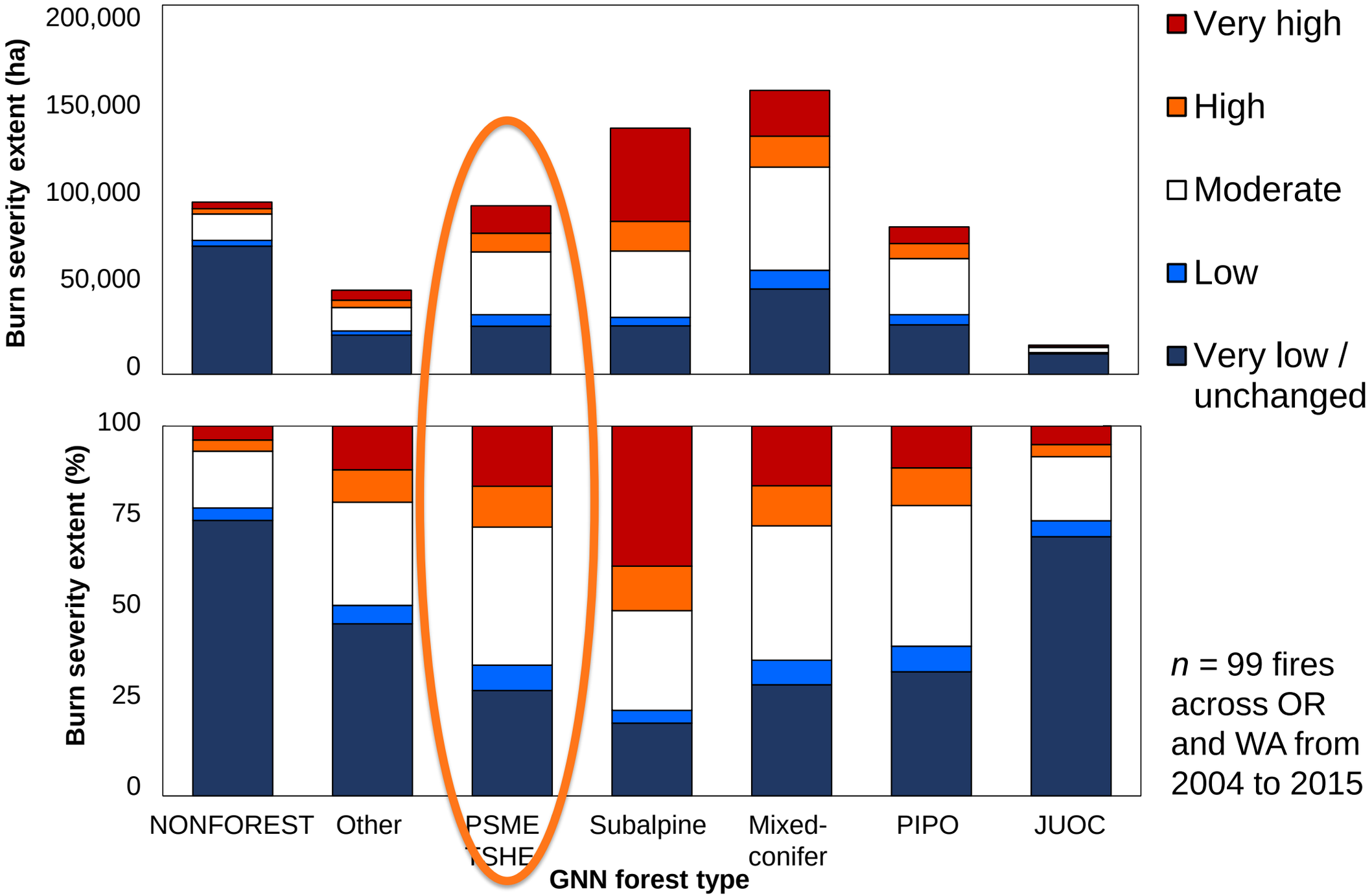
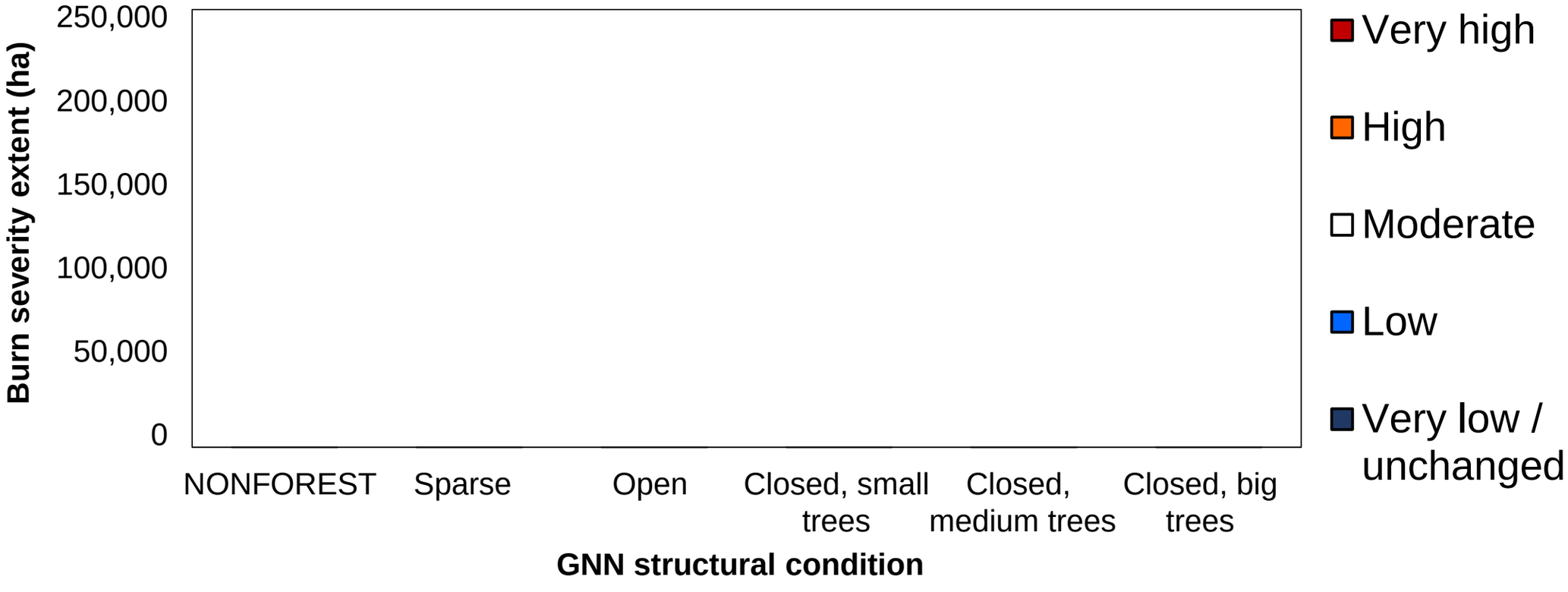


Forest structure affects the distribution of low- and high-severity fire



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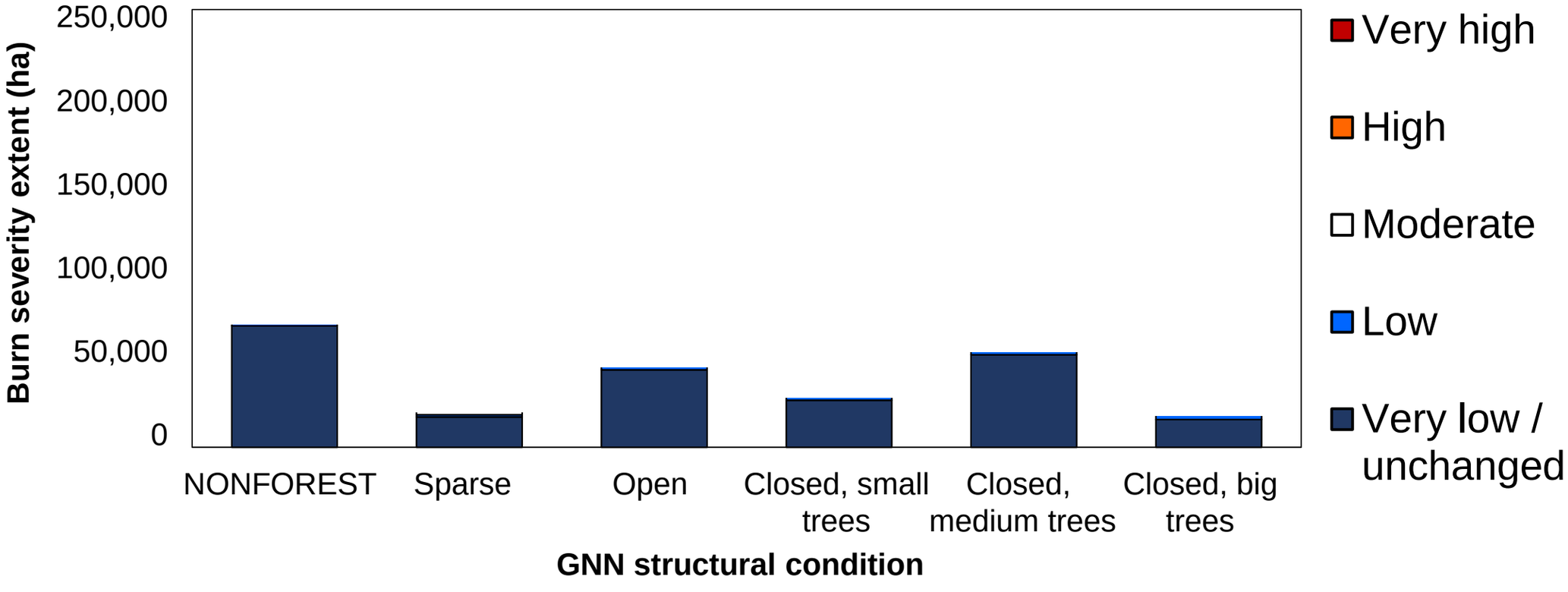

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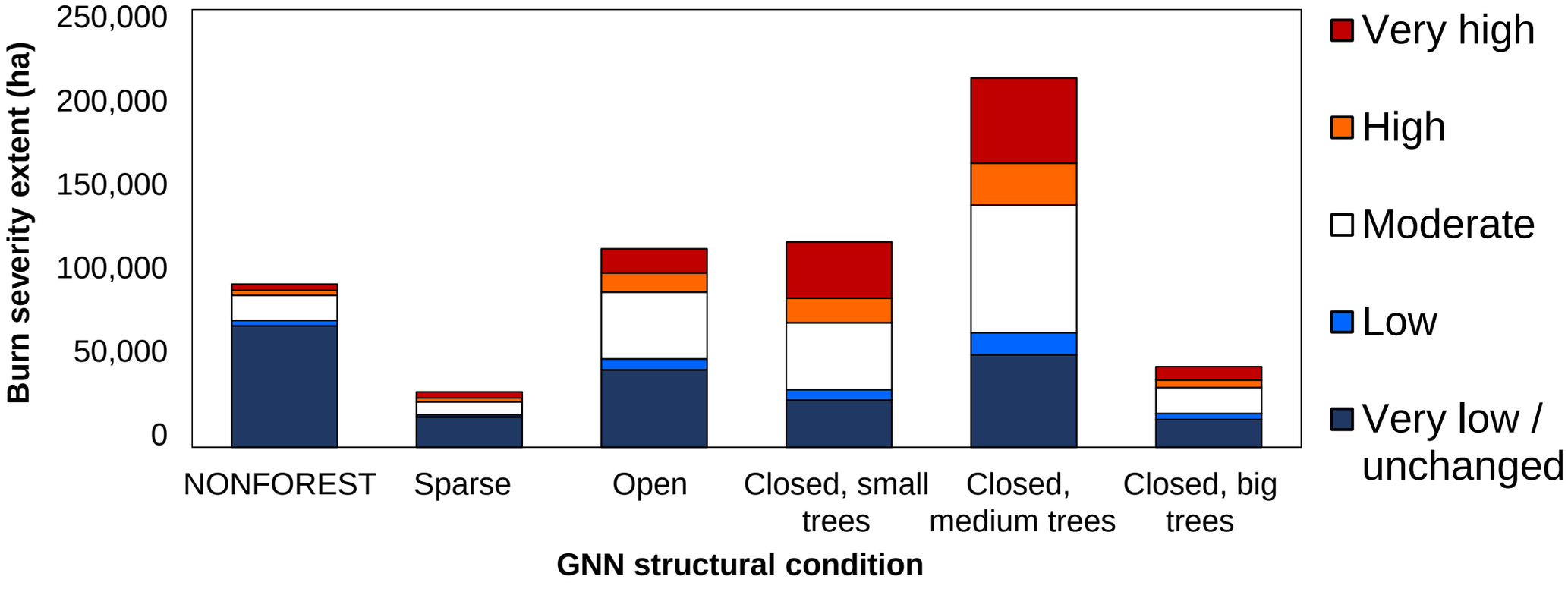

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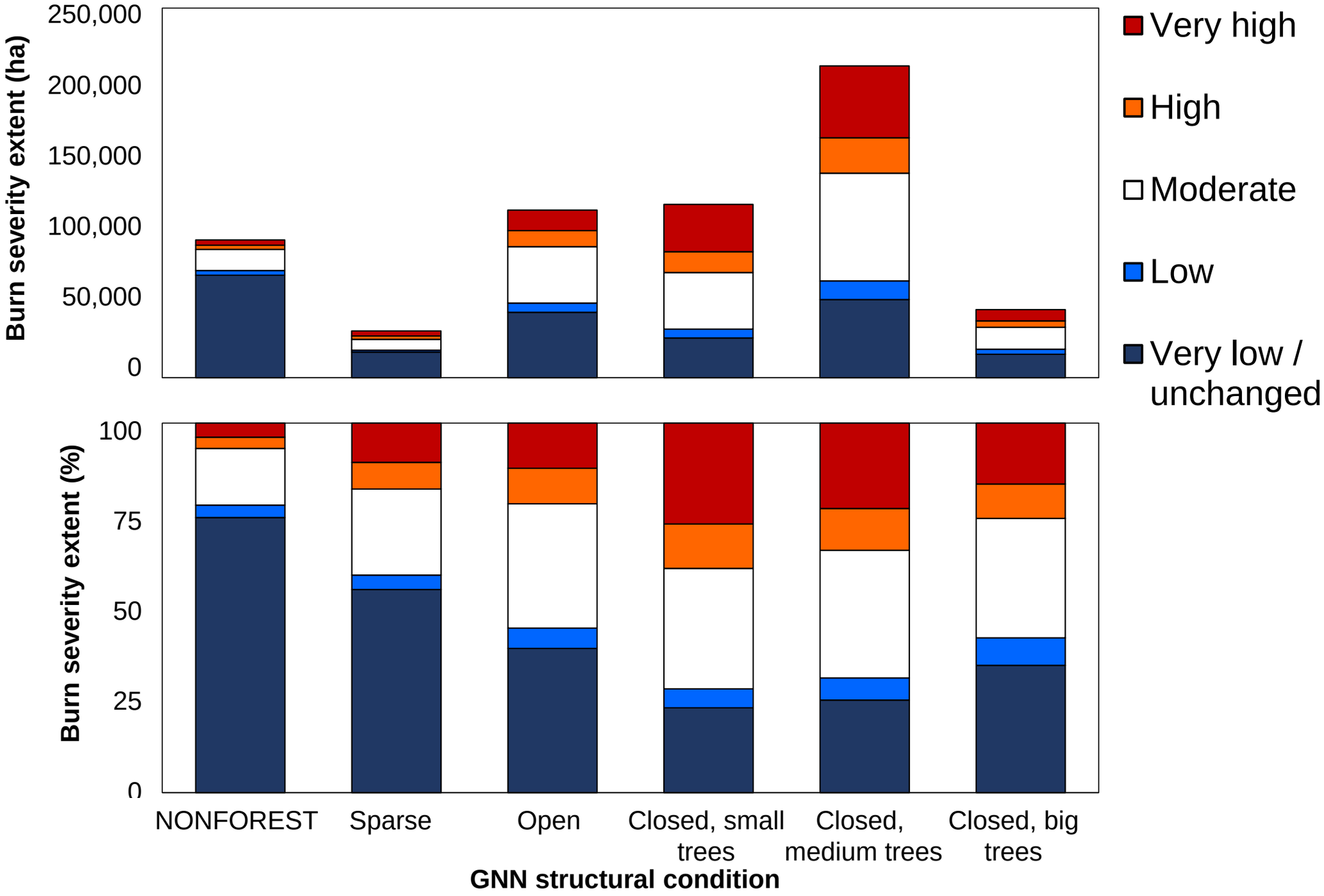

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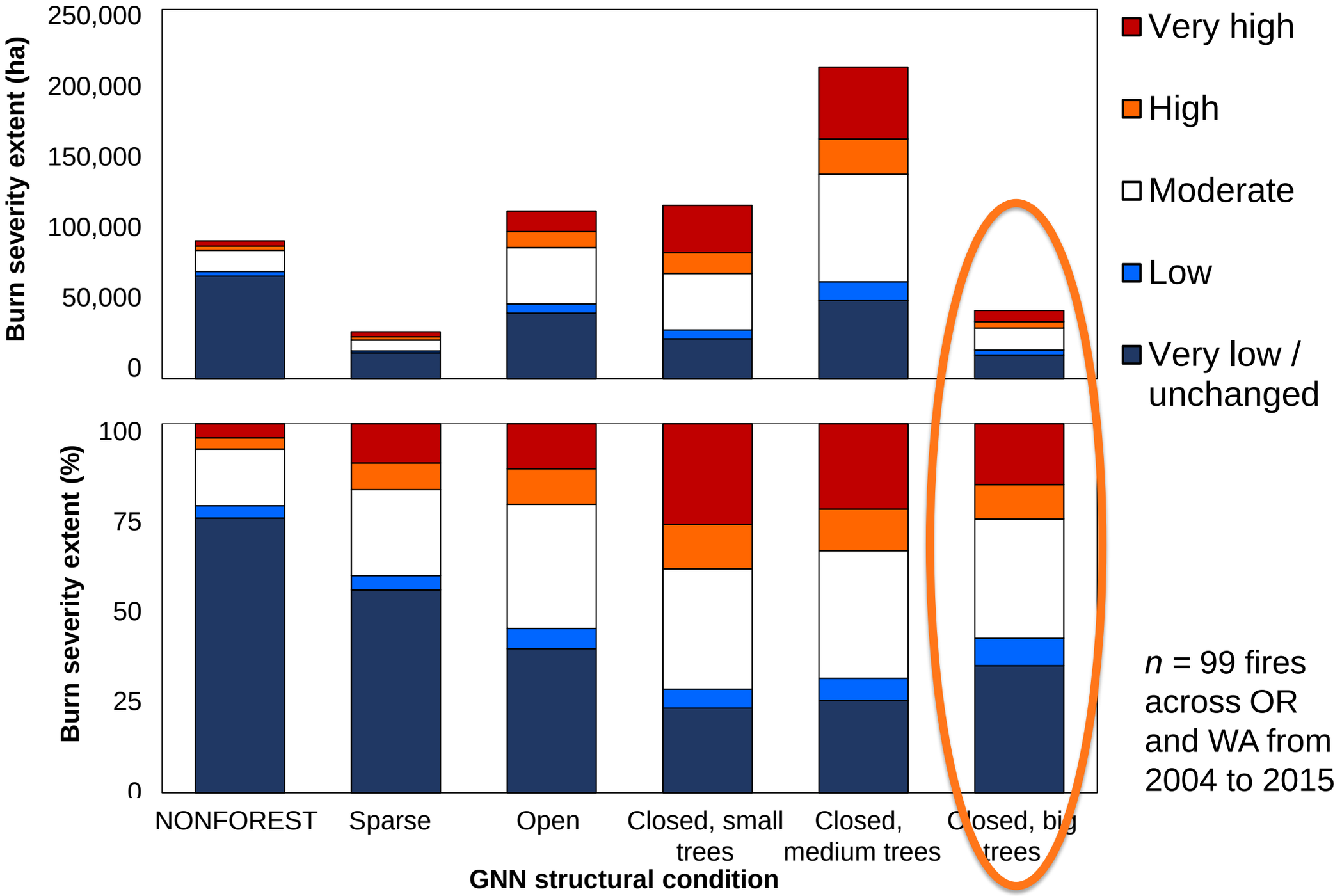


Implications for burn severity assessments

- Recognize that all refugia are not equal; nonforest and late-successional forest are two ends of a spectrum.
- Use off-the-shelf maps with caution; consider forest mask for forest applications.
- Incorporate mapping uncertainty, fire weather, and topography.

Mt. Hood Complex, OR, 2006 (2012)

Key points

1. Forest fire refugia vary with pre-fire composition and structure.

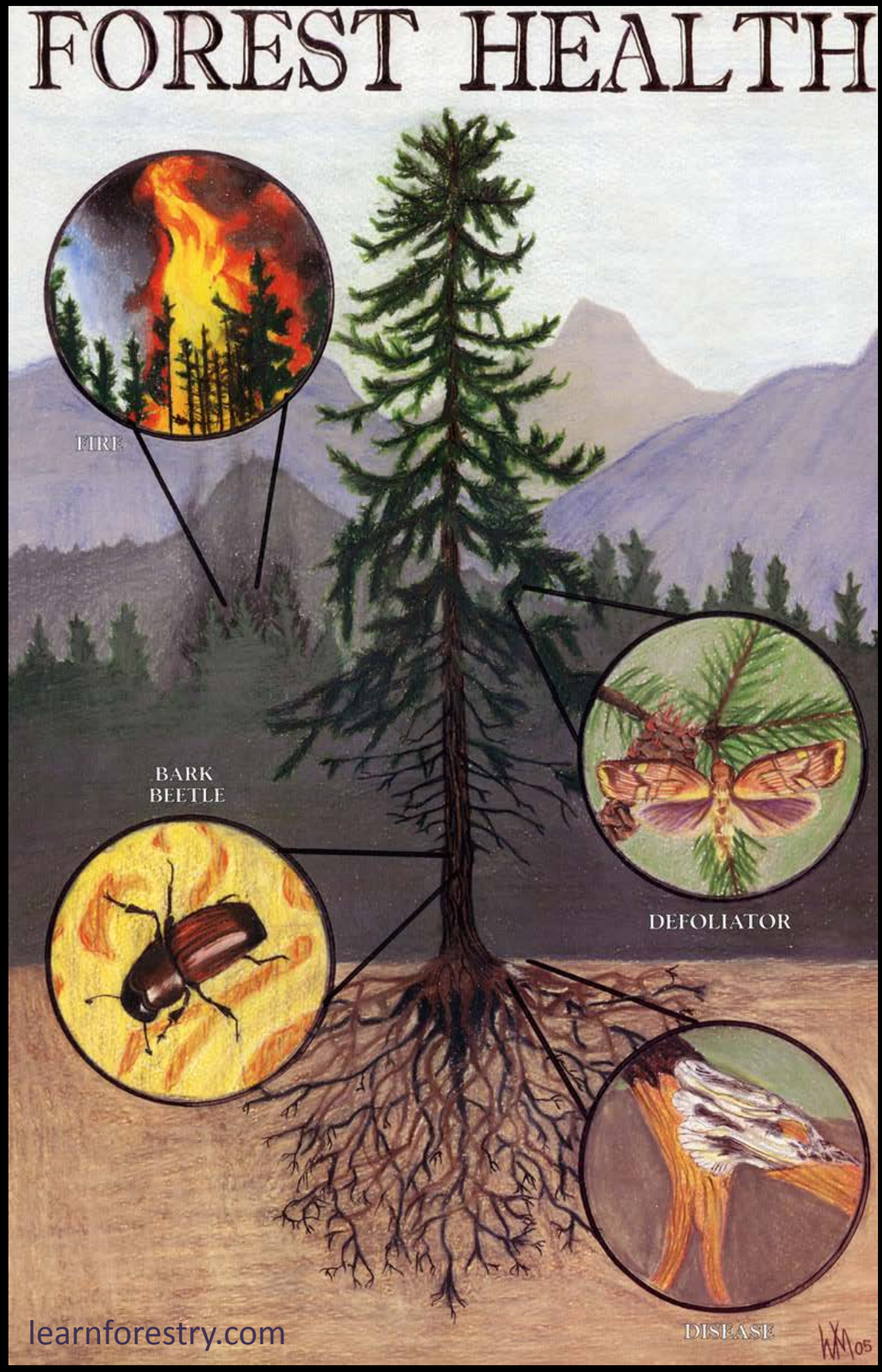
2. Late-successional forests contain substantial low-severity and refugia areas.

3. Burn severity depends on pre-fire conditions, fire effects, and post-fire responses.

Table Mountain Fire, WA, 2012 (2013)

Fire

Bark beetle



Defoliator

Pathogen

Acknowledgements

- MTBS, GAP, GNN map makers
- Oregon State University College of Forestry
- Landscape Fire and Conservation Science Research Group: Meg Krawchuk, Anna Barros, Nathan Blades, Will Downing, Kurt Frei, Andrew Merschel, Anna Talucci, Clare Tortorelli
- Ray Davis, Matt Gregory, Zhiqiang Yang
- OSU Pyromaniacs and Fierylabs

Table Mountain Fire, WA, 2012

Questions?

High-severity fire = refugia for lodgepole pine?
(Table Mountain Fire)

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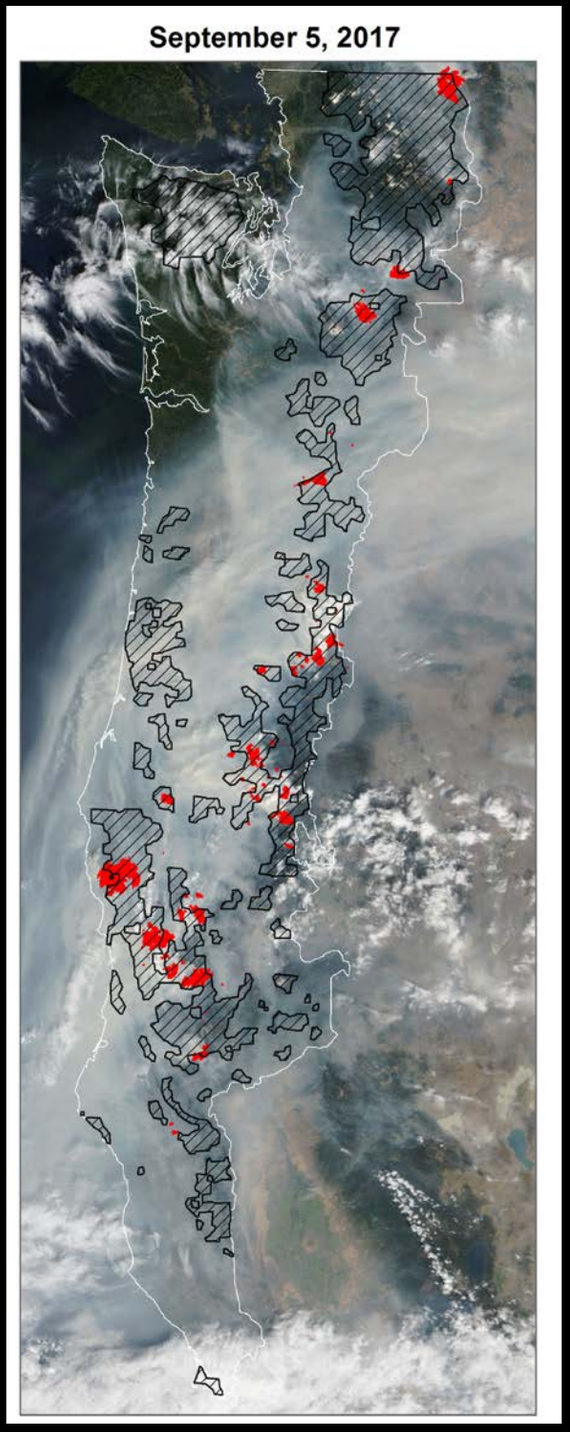
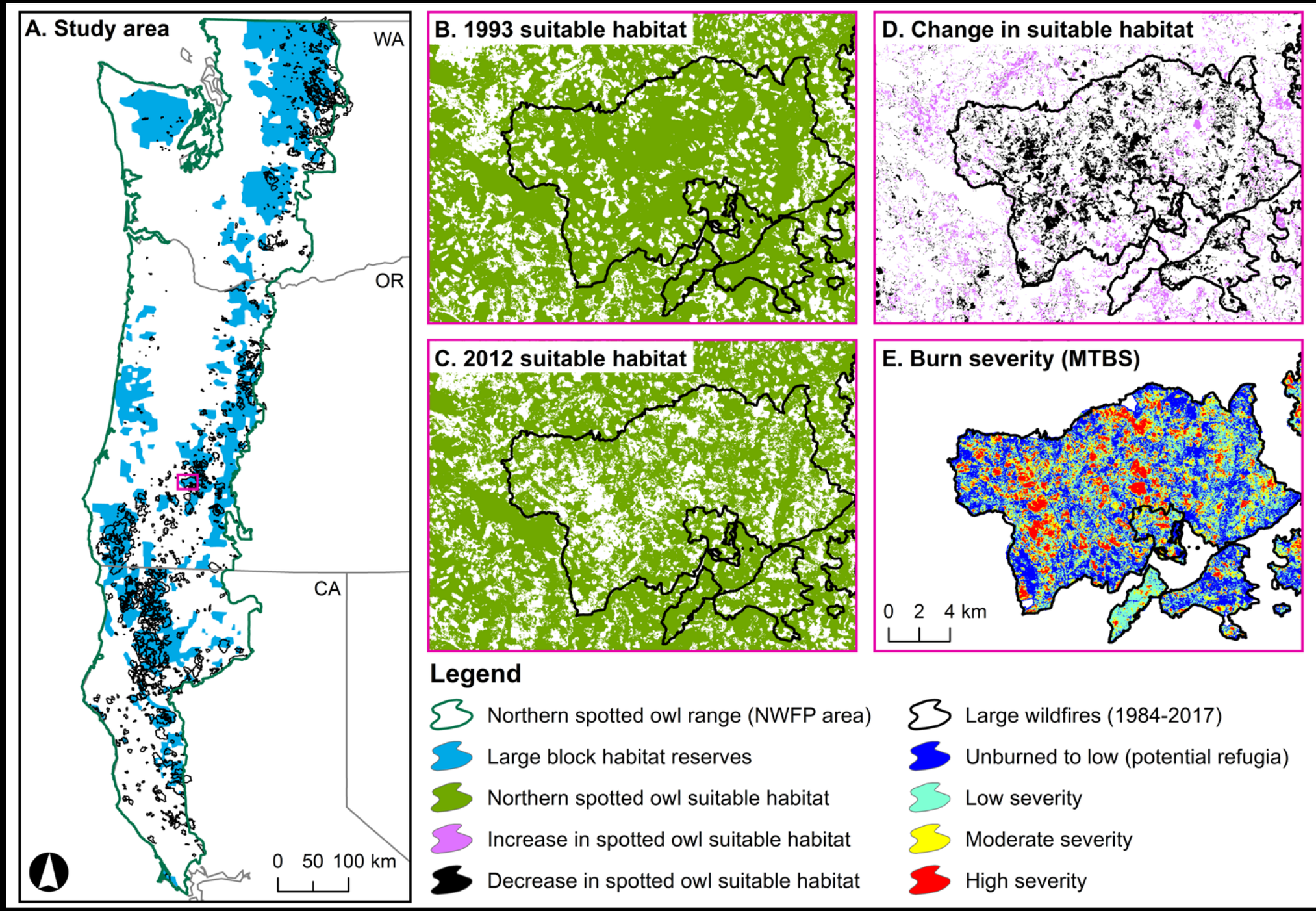
Next steps: Fire refugia in spotted owl habitat

- The northern spotted owl (NSO) evolved with frequent fire in a portion of it's range.
- High-severity fire has emerged as a driver of habitat change in mature and old forests (habitat for NSO and other species) and the increasing frequency of large wildfires is of concern.
- Forest managers and planners would benefit from a quantitative understanding of locations that are less vulnerable to stand-replacing fire and more likely to persist in a hotter, drier future.



2017 fires (red), smoke, and late-successional habitat reserves (hatched) across the US Pacific Northwest, 9/5/17

Study area and example of fire effects on spotted owl habitat



Study objectives

1. Advance a species-centric approach to characterize burn severity in terms of spotted owl habitat suitability.

2. Develop and validate statistical models of fire refugia in recently burned spotted owl habitat based on topographic and fire weather indices.

3. Scale refugia predictions from recent fires to broader landscapes across the region and under future climatic conditions.

4. Work with forest and fire managers, planners, and regulatory agencies to integrate fire refugia with ongoing conservation and recovery initiatives.

Pole Creek Fire, OR, 2012 (2013)