Oregon State University
College of Forestry

Introduction to Quantitative Wildfire Risk Assessments

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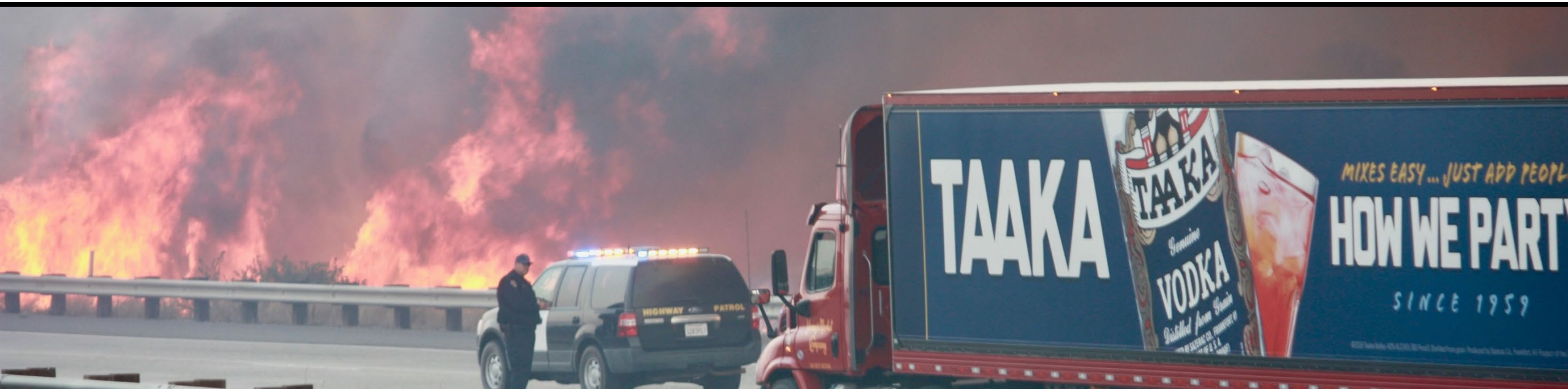
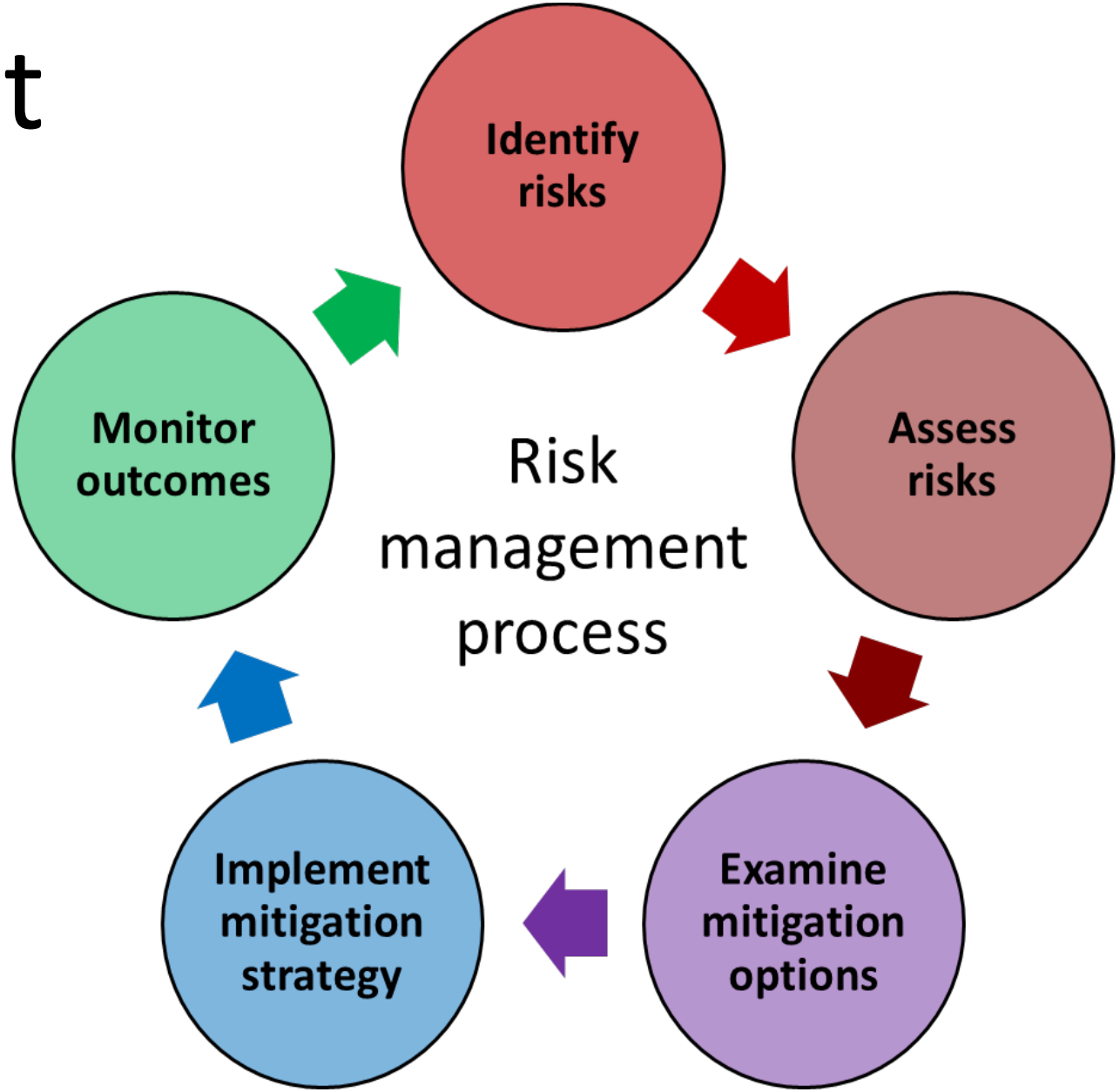


Risk management process

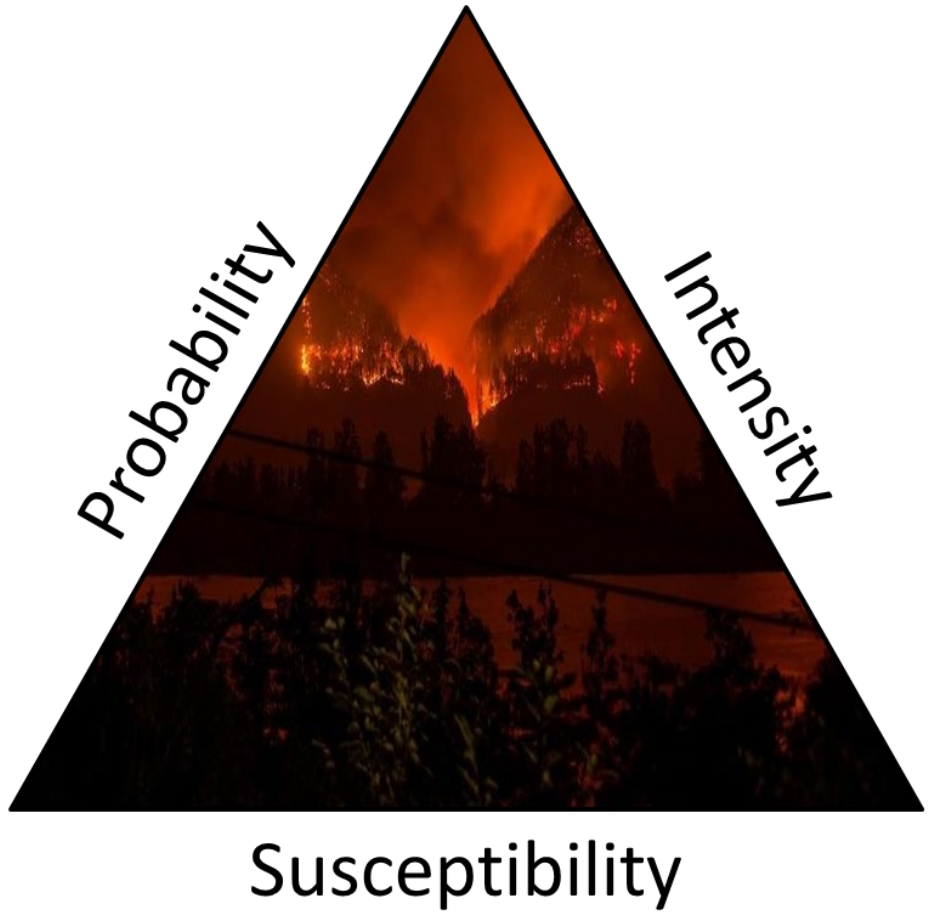


Important risk management terminology

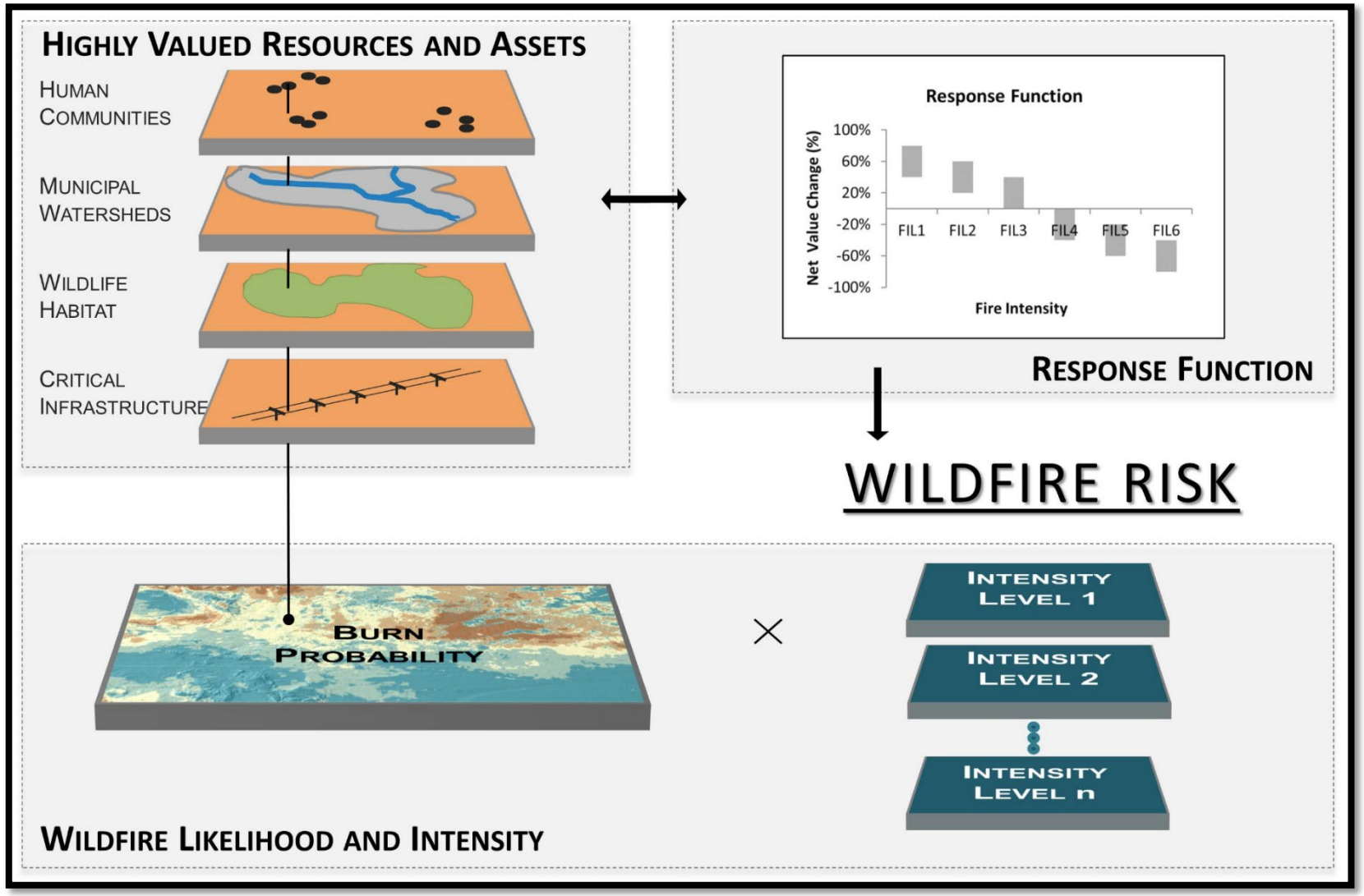
Wildfire risk vs. hazard

- Hazard assessment vs. effects analysis
- Burn probability
- Fire intensity
- Susceptibility
  - Response functions
  - Relative importance
- Conditional net value change
- Expected net value change

Community exposure



Quantitative wildfire risk assessment: cNVC a formal system for quantifying fire risk



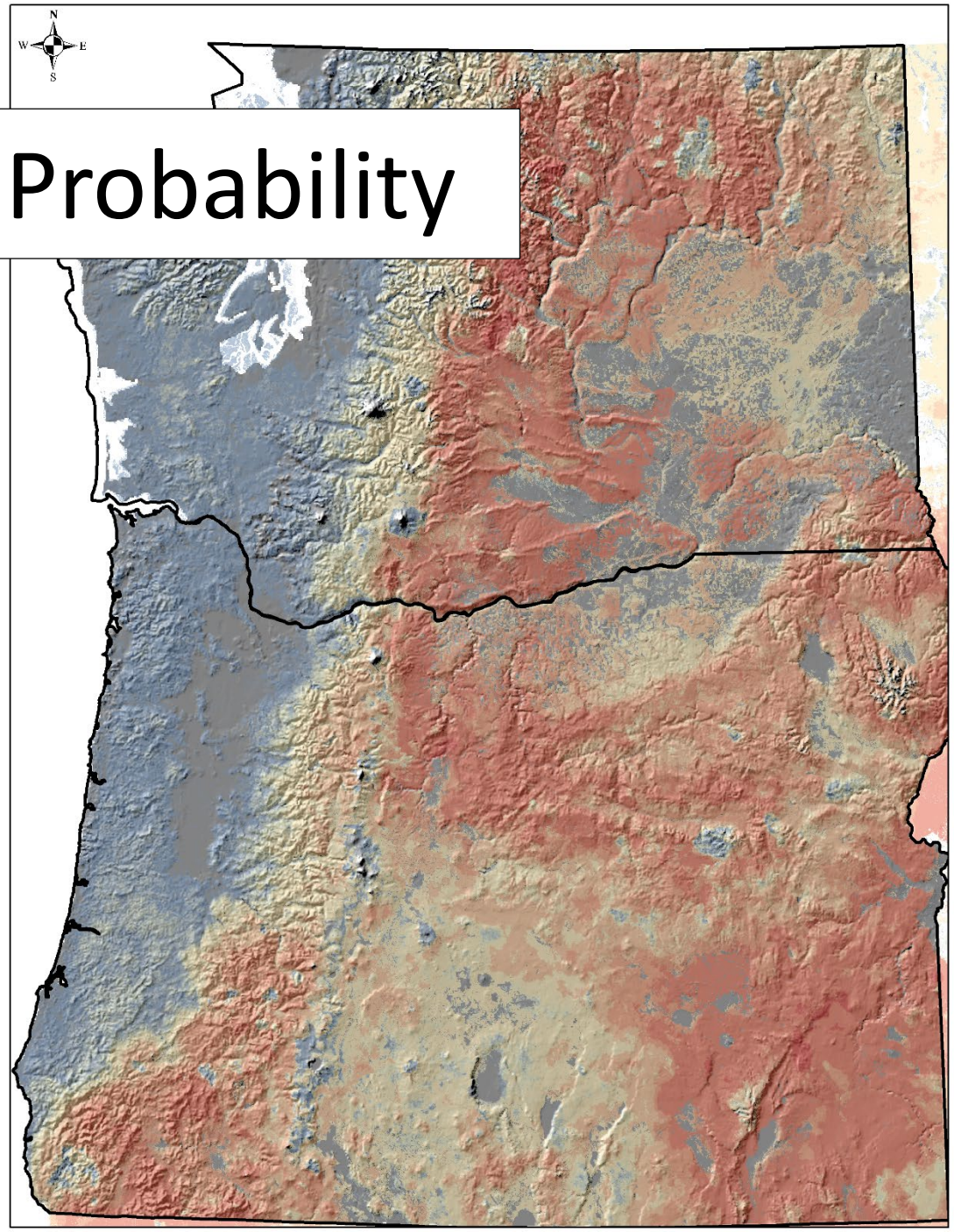
Scott et al. 2013

Pacific Northwest Quantitative Wildfire Risk Assessment: Methods and Results

Prepared by:

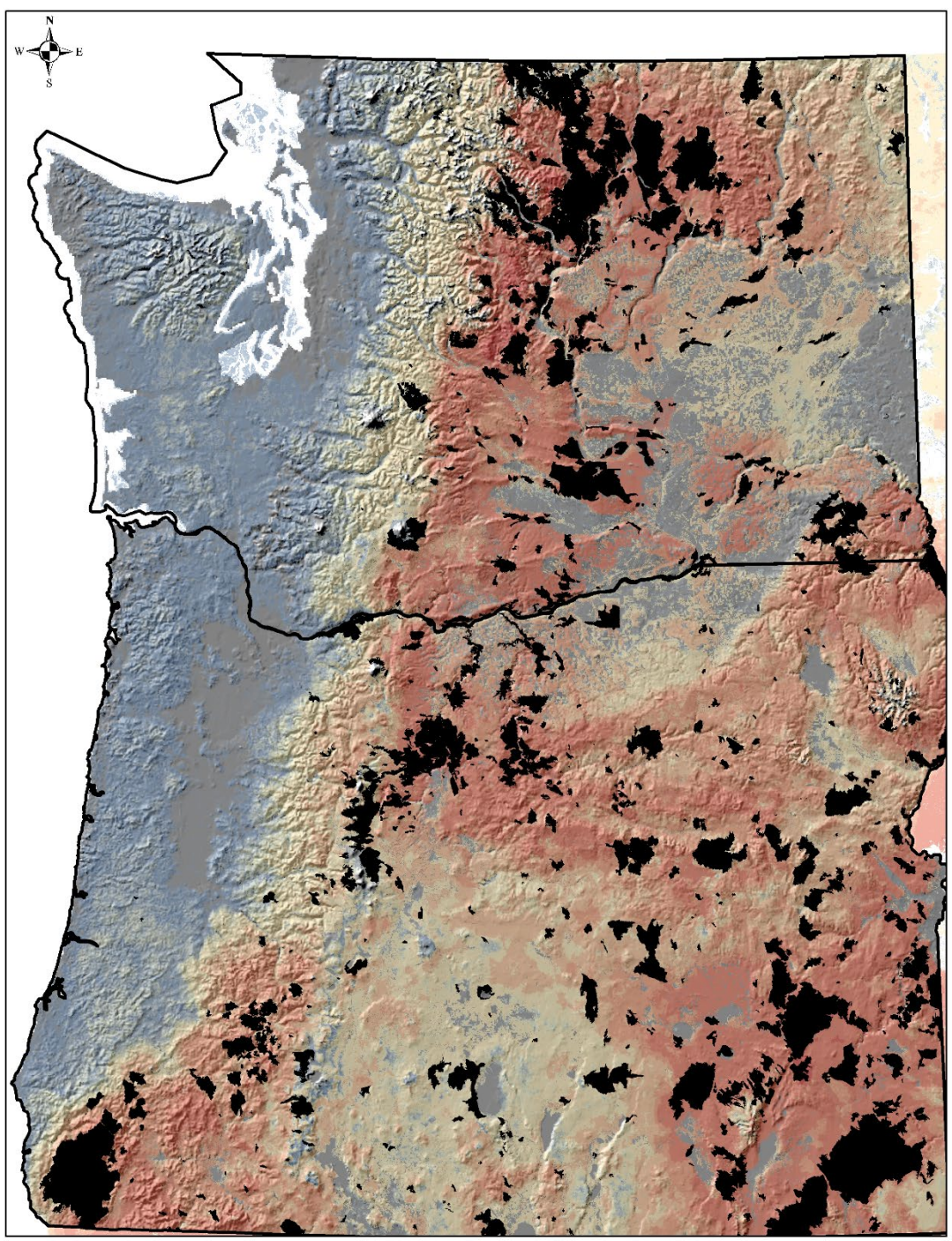
Julie W. Gilbertson-Day, Joe H. Scott, Kevin C. Vogler, and April Brough
Pyrologix LLC

Burn Probability



Annual burn probability

- 0
- 0 - 0.0001
- 0.000100001 - 0.0003
- 0.0003 - 0.0006
- 0.0006 - 0.001
- 0.001000001 - 0.003
- 0.003 - 0.006
- 0.006 - 0.01
- 0.010000001 - 0.03
- 0.03 - 0.047348



Fire intensity

– measured by flame length

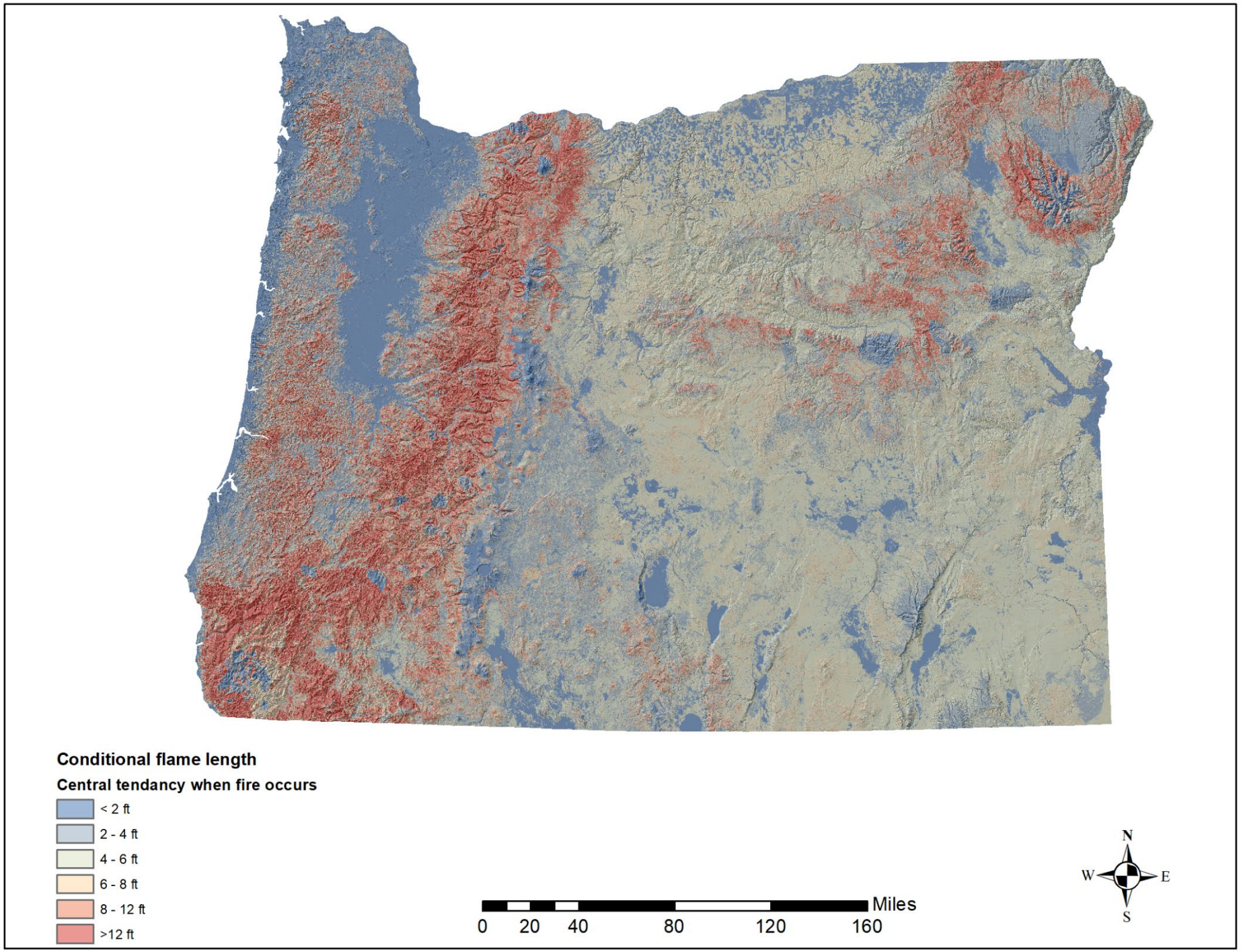


Table 4. HVRA and sub-HVRA identified for the Pacific Northwest Region wildfire risk assessment and associated data sources.

HVRA & Sub-HVRA	Data source
Infrastructure	
Electric transmission lines – high & low voltage	Electric Power Transmission Lines extracted from the Homeland Security Infrastructure Program (HSIP) database.
Railroads	Railroad features extracted from the Homeland Security Infrastructure Program (HSIP) database.
Roads – Interstates and State highways	Interstates and highways extracted from the Homeland Security Infrastructure Program (HSIP) database. Removed smaller roads (SHIELD_CL=0) from highways.
Communication sites and cell towers	Communication sites, towers, and antennas and cell towers extracted from the Homeland Security Infrastructure Program (HSIP) database.
Seed orchards	Extracted from the Pacific Northwest Region Corporate database to represent seed orchard assets across the Region.
Sawmills	Wood Product Manufacturing Facilities extracted from the Homeland Security Infrastructure Program (HSIP) database.
High and low developed rec sites	Recreation sites/structures mapped by USFS, USFWS, NPS, BLM, ODF, and DNR and including state, county, and local parks and campgrounds. High vs. low investment level assigned based on dataset attributes.
Ski Areas	OR and WA ski area boundaries, digitized outer edge and infrastructure using Google Earth imagery
Historic buildings	Historic buildings as recorded by the National Register of Historic Places
People and Property	
Where People Live (WPL) by density class	Housing density classes as developed by the West Wide Wildfire Risk Assessment project
USFS Private Inholdings	Private inholdings on USFS lands extracted from the Basic Ownership layer by querying "NON-FS". NPS lands were removed from the NON-FS lands before including in this dataset. Refined to private ownership using BLM Ownership (OWNERSHIP_POLY) and BLM Surface Management Agency (BLM_SMA_FS_update).

Timber	
USFS Active Management and NWFP Matrix Lands	A Spatial Database for Restoration Management Capability on National Forests in the Pacific Northwest USA, (Ringo *et al.*, 2016). Matrix lands in OR and WA from Northwest Forest Plan.
Tribal Owned/Colville Reservation Commercial Timber	American Indian/Alaska Native/Native Hawaiian (AIANNH) Areas Shapefile from U.S. Census Bureau as Tribal ownership overlay along with Colville Reservation Commercial forestland
Private Industrial	Privately owned, industrial timber lands extracted from the Atterbury Consultants ownership maps for Oregon and Washington (selected attributes containing IFPC, REIT, and TIMO)
BLM Harvestable/Potential	Harvest Land Base from the ROD for western OR, O&C lands, Coos Bay Wagon Rd, Public Domain lands, and the BLM-owned polygons from the E. WA Resource Management Plan.
State owned for Oregon and Washington	State-owned lands in OR and WA excluding State Parks, State Fish and Wildlife lands, and Parks and Recreation lands.
Fire Regime Groups 1,3,4/5	R6 Forest Structure Restoration Needs Update Analysis – (DeMeo *et al.*, In Press)
Size classes <10in., 10-20in., >20in.	R6 Forest Structure Restoration Needs Update Analysis – (DeMeo *et al.*, In Press)
Vegetation Condition	
Seral state departure by FRG group	R6 Forest Structure Restoration Needs Update Analysis – (DeMeo *et al.*, In Press)

Table 4. (Continued) HVRA and sub-HVRA identified for the Pacific Northwest Region wildfire risk assessment and associated data sources.

Watersheds	
Watersheds	Washington Drinking Water System Boundaries for watershed boundaries and surface water intake locations Oregon Surface Drinking Water Source Areas and intake locations from EPA Safe Drinking Water Information System (SDWIS)
Erosion potential	Developed by USFS Remote Sensing Applications Center (RSAC)
Wildlife	
Marbled murrelet	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Northern spotted owl	Predicted habitat suitability map (Glenn *et al.*, 2017)
Sage grouse habitat	Wildland Fire Decision Support System (WFDSS) - 2015 greater sage grouse (GRSG) Land Use Plan (LUPs) Allocations
Resistance/Resilience class	USDA - Natural Resources Conservation Service, Index of Relative Ecosystem Resilience and Resistance across Sage-Grouse Management Zones
Bull trout	StreamNet Generalized Fish Distribution, Bull Trout (January 2012)
Chinook salmon	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Coho salmon	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Steelhead trout	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Redband trout	Non-Anadromous Redband Trout (RBT) Range-wide Database - ODFW
Coastal cutthroat trout	StreamNet Generalized Fish Distribution, Coastal Cutthroat Trout (January 2012) -
Lahontan cutthroat trout	StreamNet Generalized Fish Distribution, Lahontan Cutthroat Trout (January 2012)

Table 6. Response functions for the Infrastructure HVRA to highlight electric transmission lines.

Sub-HVRA	FIL1	FIL2	FIL3	FIL4	FIL5	FIL6	Share of RI[1]	Acres
Trans-Line- High voltage	10	0	0	-10	-50	-70	40.86%	905,585
Trans-Line- Low voltage	-10	-20	-50	-70	-80	-90	16.79%	743,972
Railroads	-10	-20	-30	-40	-50	-50	16.57%	612,073
Interstates	0	-5	-10	-15	-20	-30	4.74%	175,191
State Highways	0	-5	-10	-15	-20	-30	12.98%	958,745
Communication Sites/Cell Towers	-10	-30	-60	-80	-100	-100	3.65%	80,924
Seed Orchards	-50	-90	-100	-100	-100	-100	0.02%	2,704
Sawmills	-10	-20	-30	-40	-60	-80	0.10%	1,448
Ski Areas	0	-10	-20	-40	-60	-80	0.44%	16,175
Recreation High Developed	-10	-30	-70	-90	-100	-100	1.93%	26,793
Recreation Low Developed	-10	-30	-70	-90	-100	-100	1.17%	129,886
Historic Structures	-30	-50	-70	-100	-100	-100	0.73%	8,140

[1] Within-HVRA relative importance.

The share of HVRA importance is based on relative importance per unit area and mapped extent.

Integrating HVRAs with differing units of measure (for example, habitat vs. homes) requires relative importance (RI) values for each HVRA/sub-HVRA. These values were identified in the RI workshop, as discussed in Section 3. The final importance weight used in the risk calculations is a function of overall HVRA importance, sub-HVRA importance, and relative extent (pixel count) of each sub-HVRA. This value is therefore called relative importance per pixel (RIPP).

The RF and RIPP values were combined with estimates of the flame-length probability (FLP) in each of the six flame-length classes to estimate conditional NVC (cNVC) as the sum-product of flame-length probability (FLP) and response function value (RF) over all the six flame-length classes, with a weighting factor adjustment for the relative importance per unit area of each HVRA, as follows:

$$cNVC_j = \sum_{i}^{n} FLP_i * RF_{ij} * RIPP_j$$

where i refers to flame length class (n = 6), j refers to each HVRA, and RIPP is the weighting factor based on the relative importance and relative extent (number of pixels) of each HVRA. The cNVC calculation shown above places each pixel of each resource on a common scale (relative importance), allowing them to be summed across all resources to produce the total cNVC at a given pixel:

$$cNVC = \sum_{j}^{m} cNVC_j$$

where cNVC is calculated for each pixel in the analysis area. Finally, eNVC for each pixel is calculated as the product of cNVC and annual BP:

$$eNVC = cNVC * BP$$

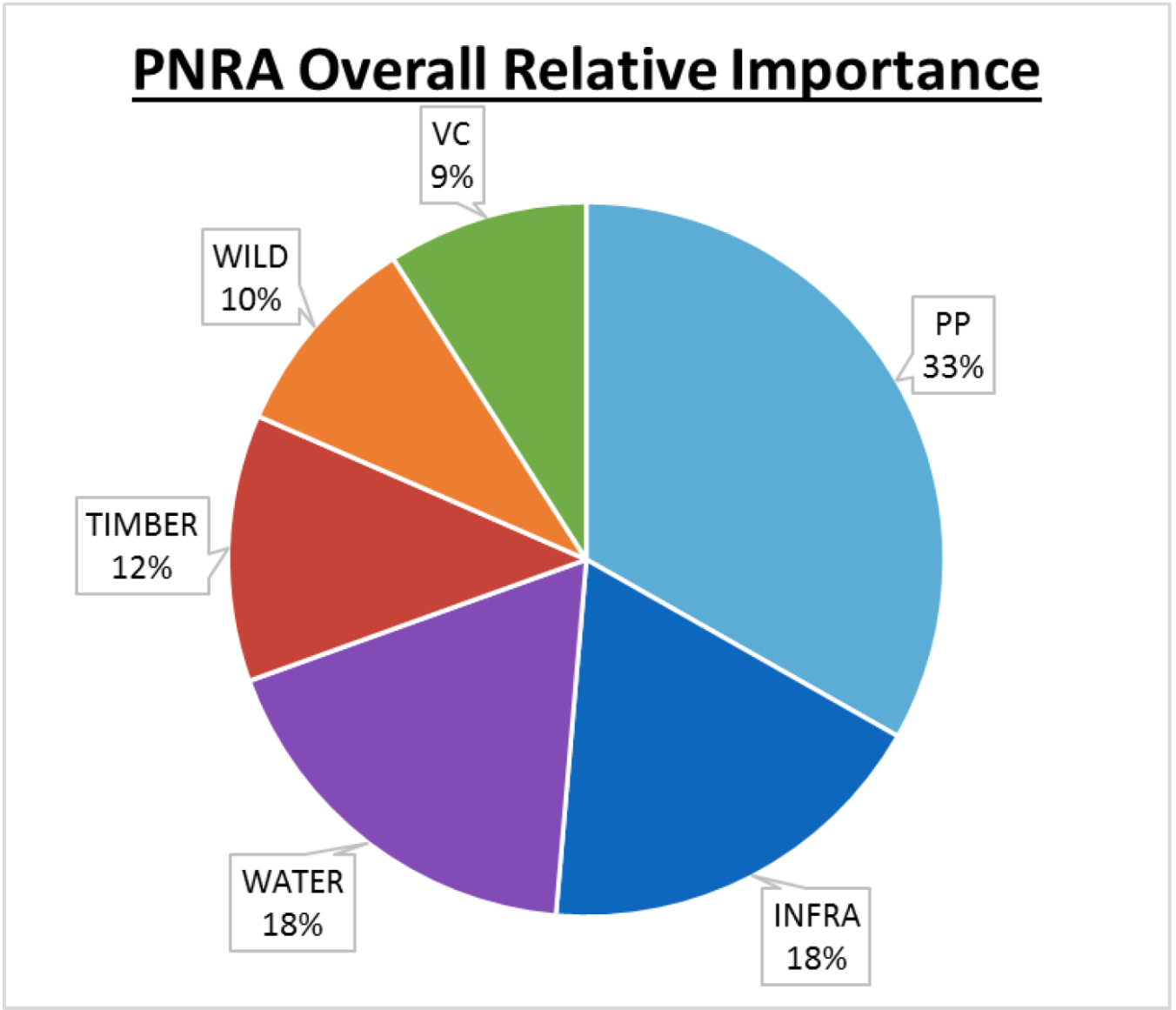
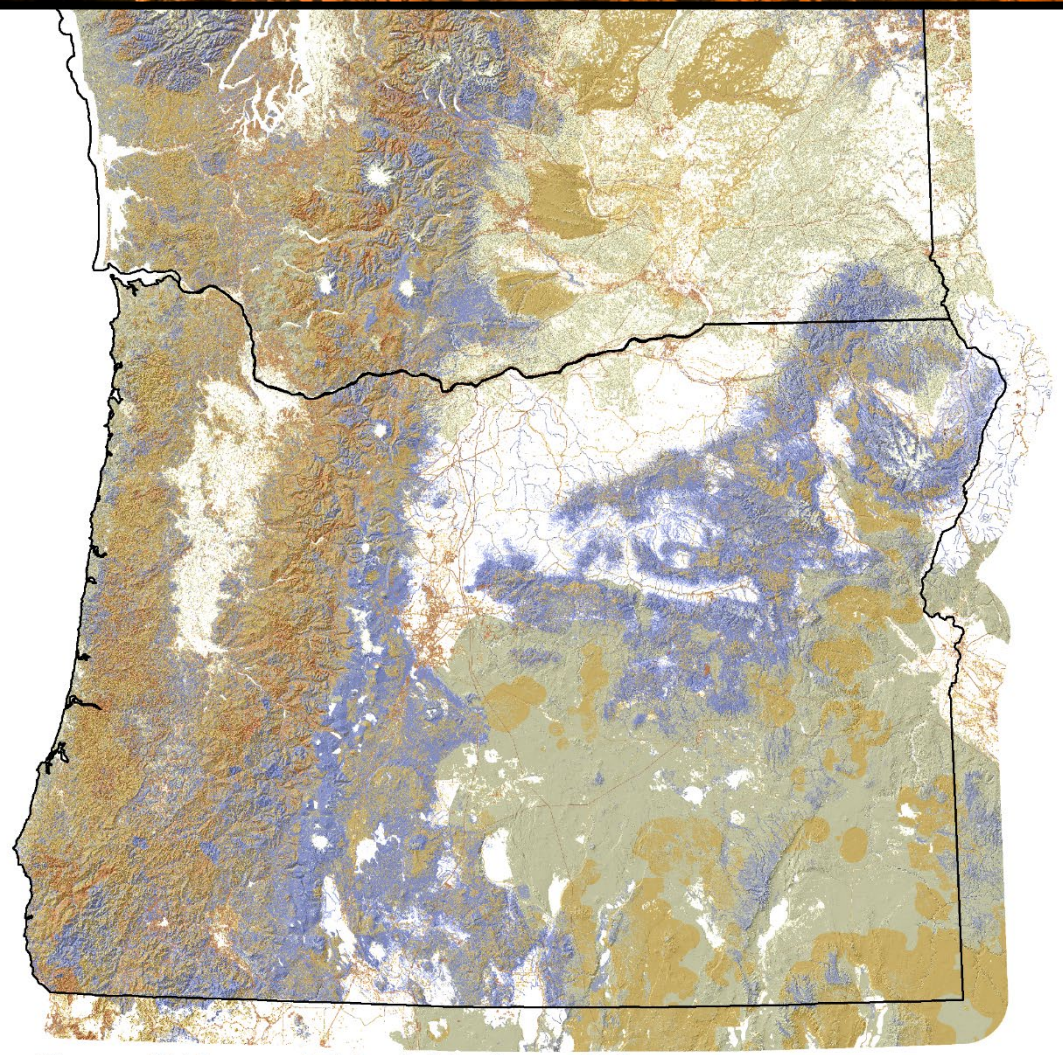
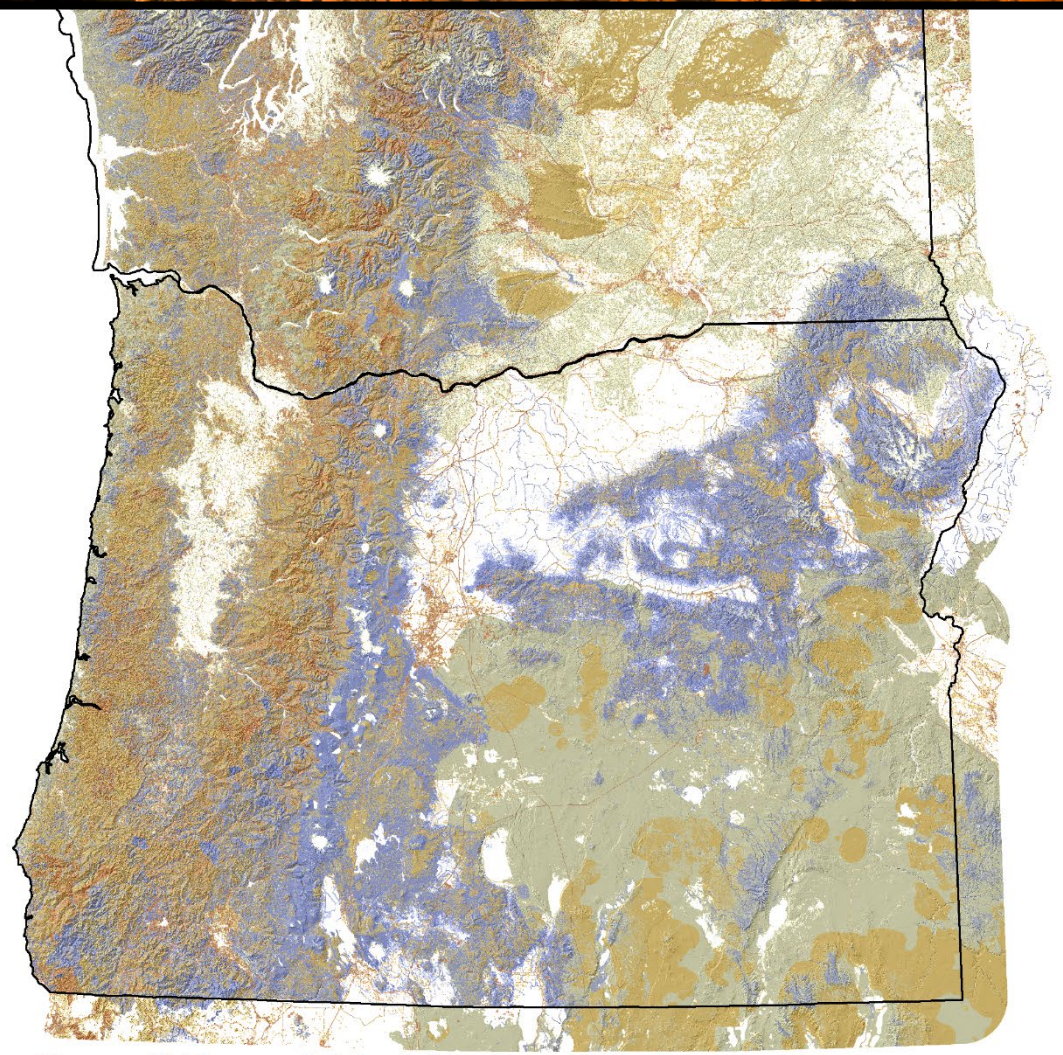


Figure 8. Overall HVRA Relative Importance for the primary HVRAs included in PNRA



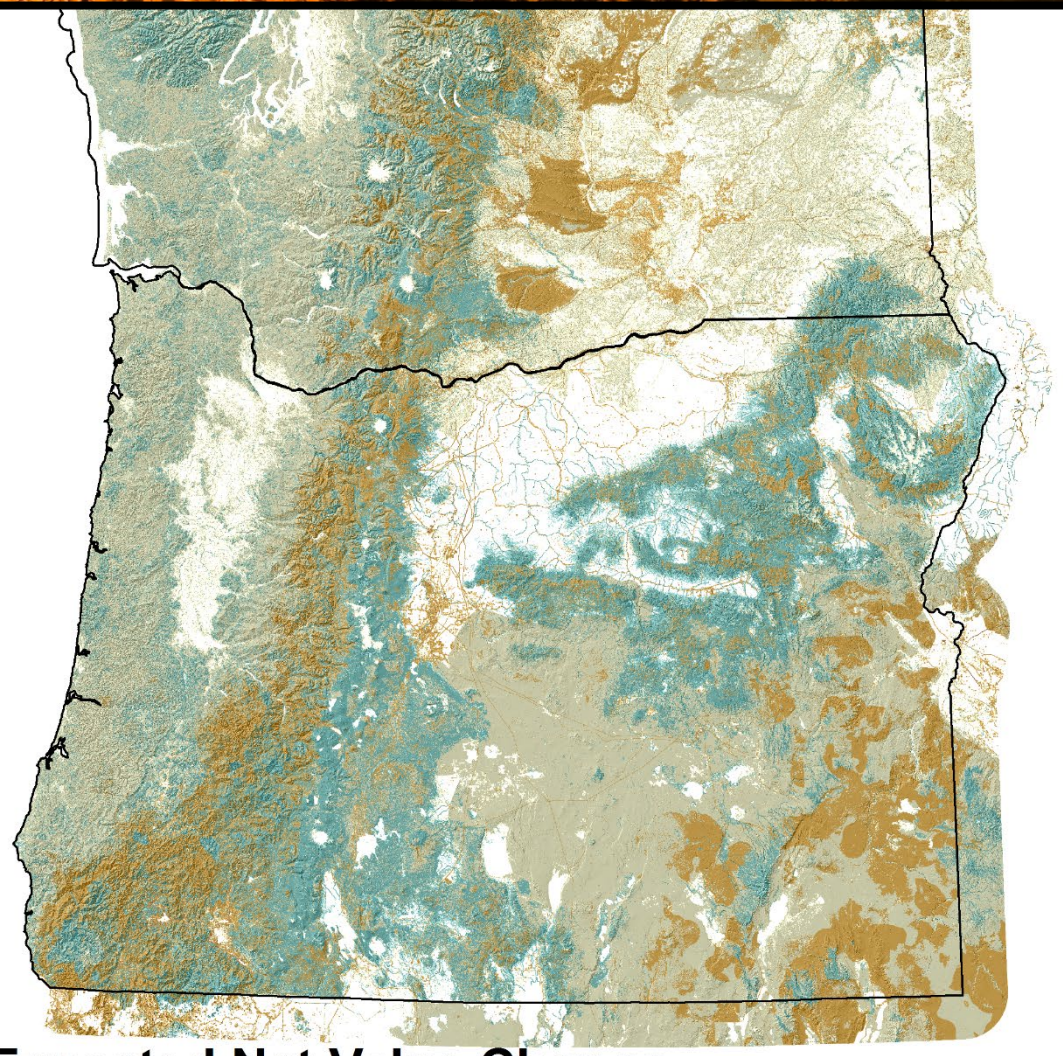
Conditional Net Value Change

-284.97 - -18.12	>-0.1 - -0.01	>0.01 - 0.10
-18.12 - -0.32	>-0.01 - 0	>0.10 - 0.32
-0.32 - -0.1	>0 - 0.01	



Conditional Net Value Change

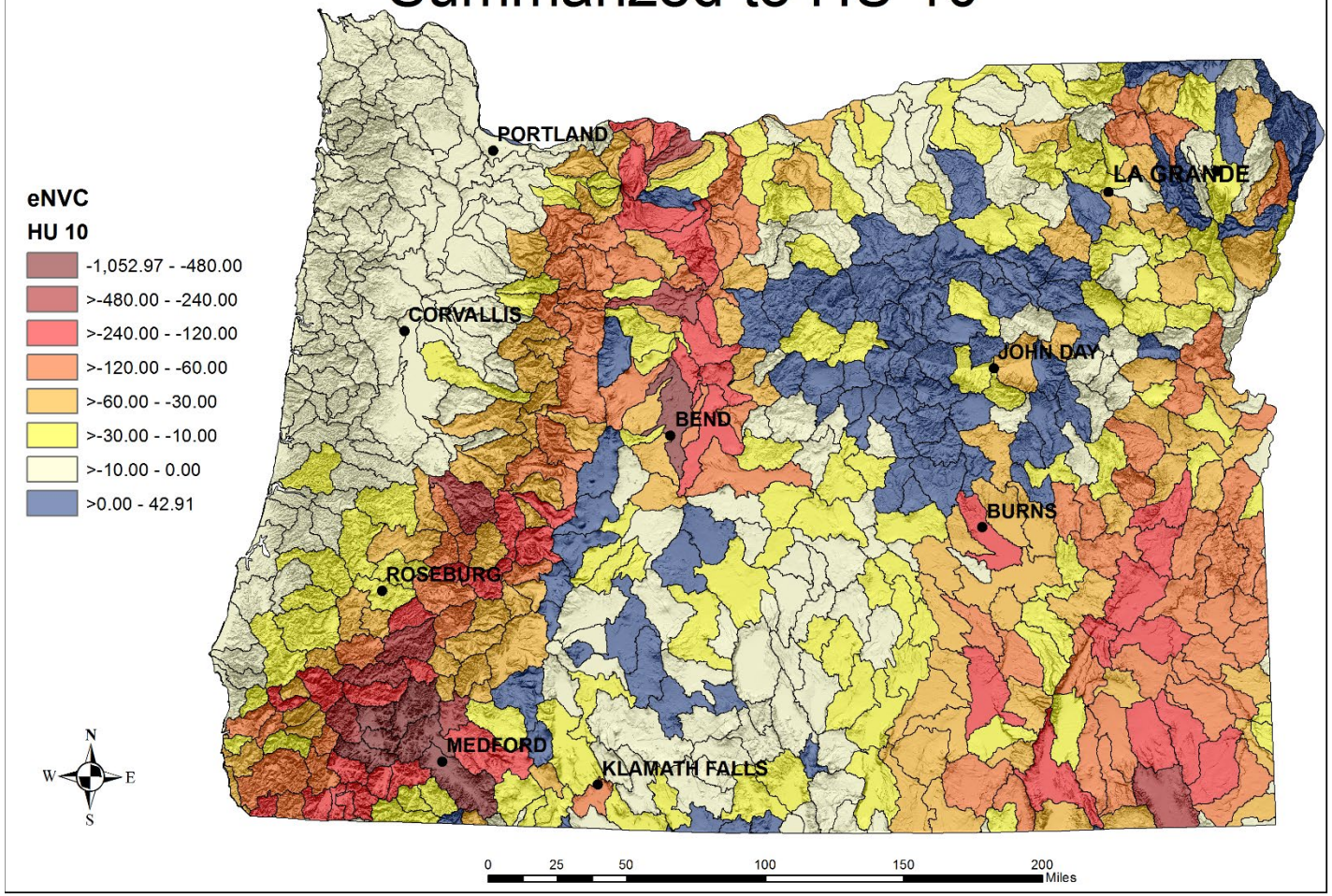
-284.97 - -18.12	>-0.1 - -0.01	>0.01 - 0.10
-18.12 - -0.32	>-0.01 - 0	>0.10 - 0.32
-0.32 - -0.1	>0 - 0.01	



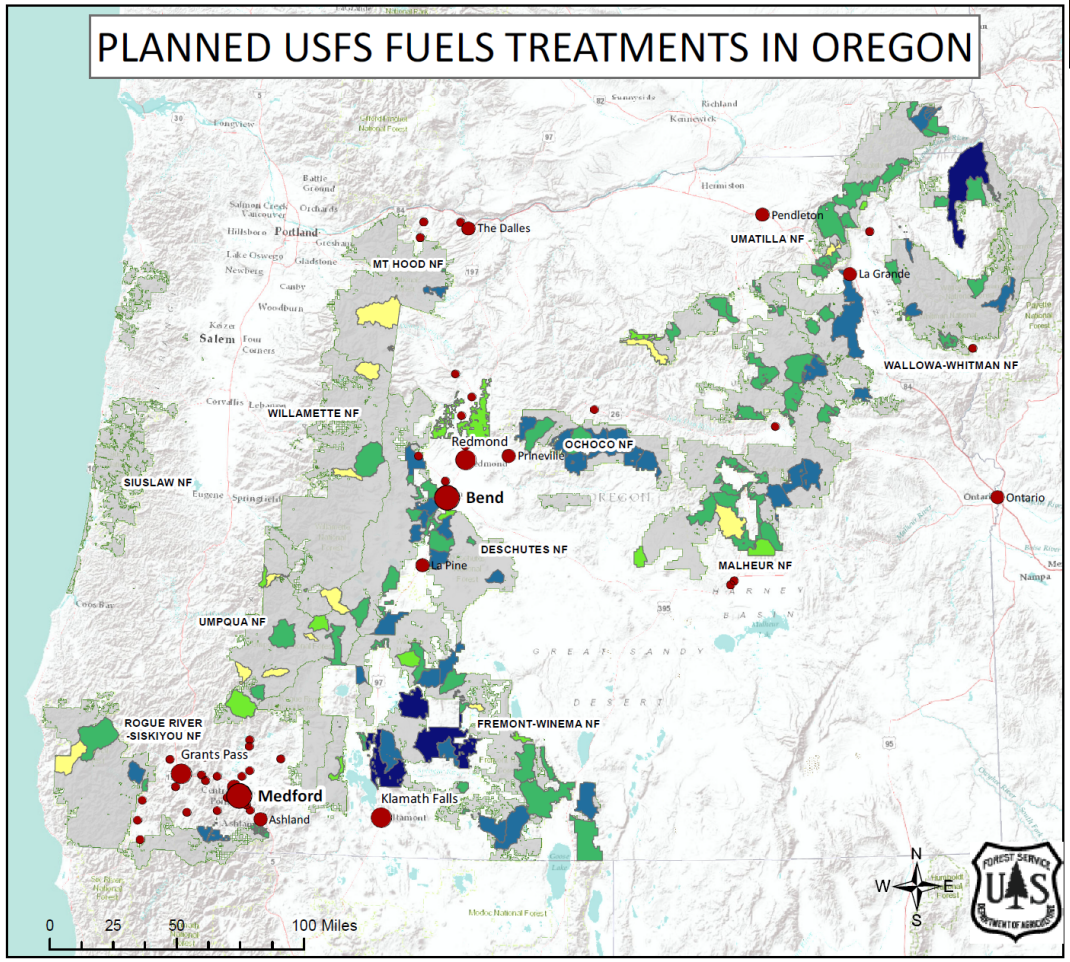
Expected Net Value Change

-0.23 - -0.10	-0.005 - -0.0001	0 - 0.001
-0.10 - -0.01	-0.0001 - 0	0.001 - 0.0033
-0.01 - -0.005	0	0.0033 - 0.005

Expected Net Value Change (eNVC) Summarized to HU 10



PLANNED USFS FUELS TREATMENTS IN OREGON



Legend

OR Top 50 Communities At Risk

# of Exposed Housing Units

- >0 - 5,000
- 5,000 - 10,000
- 10,000 - 25,000
- 25,000 - 50,000

National Forests in Oregon

US Forest Service Planned Fuels Projects

Acres of Shelf Stock

- <500
- 500-1,000
- 1,000-10,000
- 10,000-50,000
- 50,000-135,000

National Forest	Planned Prescribed Fire	Planned Mechanical Fuels Reduction	Total Shelf Stock
Deschutes	121,738	141,448	263,186
Fremont-Winema	535,349	113,201	648,550
Malheur	154,700	175,172	329,872
Mt. Hood	4,800	14,000	18,800
Ochoco	176,086	166,955	343,041
Rogue River - Siskiyou	68,465	38,447	106,912
Siuslaw		12,368	12,368
Umatilla	156,063	26,632	182,695
Umpqua	2,000	5,500	7,500
Wallowa-Whitman	157,000	72,000	229,000
Willamette	4,997	13,443	18,440
Columbia River Gorge NSA	14,000	12,000	26,000
TOTAL	**1,395,198**	**791,166**	**2,186,364**

*Reference for Top 50 Communities at Risk: Scott, Joe H.; Gilbertson-Day, Julie; Stratton, Richard D. 2018. Exposure of human communities to wildfire in the Pacific Northwest. Briefing paper. 10 p. Available at: http://pyrologix.com/ftp/Public/Reports/RiskToCommunities_OR-WA_BriefingPaper.pdf

**The term shelf stock is used to denote planned fuels reduction work that has been cleared for implementation through the NEPA process but has not yet been accomplished.

***Map captures most major project areas, but not all shelf stock is displayed.