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Multi-scale approach to fuel reduction in a fragmented landscape in eastern Oregon

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Introduction

In the western United States, the size and scale of high-intensity and high-severity fire has negatively departed from historic patterns and as a result is having adverse ecological effects on air and water quality and quantity, stream function, wildlife habitat, large and old tree structure, and soil integrity. Wildfires are also negatively affecting people and their communities. High severity wildfires are critical management and policy concerns (North et al. 2015; Thomas et al. 2017) and illustrates the persuasive need for a systematic all-lands approach. Many would agree that there is a need to proactively reduce wildfire severity and foster the resiliency of our forests. Large-scale information on threats can improve planning efficiency providing risk assessments associated with anthropogenic changes (Butler and Goldstein 2010). Consideration of multiple social, ecological, and political boundaries, and jurisdictions in land management requires effective engagement of multiple governments, regulatory and land management agencies, and administrators within them to negotiate solutions to render cross-boundary issues governable (Lidskog et al., 2011, Lidskog and Sundqvist 2013, Fisher et al, 2018).

Dry forests with active, frequent fire regimes are composed of an uneven-aged, shifting mosaic of irregularly spaced patterns of openings, and trees are typically aggregated (Churchill et al. 2013, Franklin et al. 2018). Reference sites, from both pre-settlement era reconstructions and contemporary forests with active fire regimes, indicate substantial ecosystem resilience to historical disturbances, meaning that ecosystems recover their essential structure and function after perturbation (Holling 1973). Potential changes in the relationship between forest structure and composition associated with fire exclusion and climate, may contribute to fire size,

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and severity (Agee 1993). Establishing resilient ecosystems will facilitate disturbances generate biological legacies that interact with environmental conditions to shape ecosystem recovery (Franklin et al. 2000). In addition, there is a broad scientific consensus that restoration treatments should seek to restore legacies, mosaic patterns with ecologically important openings to restore resilience and maintain ecosystem function (Franklin et al 2018).

Objectives
Strategies to accomplish the objectives that mitigate the risks and impacts of high-severity fire events should meet five criteria: Planning and implementation must include coordination across jurisdictions and ownership boundaries; Strategic use of commercial thinning, prescribed fire, and managed wildfire should be included in forest treatments; Treatments should identify and implement cross-boundary "pre-fire response" plans and strategies; Issues with governance must address inequities associated with liability of cross-boundary fires; And, each treatment should include best available science, incorporating and identifying people's needs. Treatments should develop systems change by transforming the underlying assumptions and policies that govern existing processes and procedures that directly supports cross-boundary management.

Methods

Site Description
A series of forest treatments (joint Nature Conservancy/US Forest Service Big Coyote Fuels Reduction Project: http://www.fs.fed.us/r6/frewin/projects/analyses/coyotenepa/index.shtml) were implemented from 2001 through 2018 in the upper Sycan River Watershed (HUC 6), bounded by the coordinates: NW corner: 42°52'44.96"N, 121°11'04.55"W; NE corner: 42°52'42.41"N, 121°06'36.44"W; SE corner: 42°52'33.62"N, 121°09'35.19"W; SW corner: 42°52'38.52"N, 121°14'04.46"W (Bienz et al. *In Press*).

Low elevations (4,900 ft MSL) are predominately ponderosa pine (*Pinus ponderosa*) and lodgepole pine (*Pinus contorta*), while higher elevations (8,500 ft MSL) contain mixed conifer stands consisting of ponderosa pine, white fir (*Abies concolor*), sugar pine (*Pinus lambertiana*) Mountain Hemlock (*Tsuga mertensiana*), and an occasional western white pine (*Pinus monticola*). Aspen (*Populus tremuloides*) clones and juniper (*Juniperis occidentalis*) woodlands also exist in the project area. Historical (1560 – 1865) median fire interval of the Sycan area was 10.7 years (range 3–37 years) based on fire scars (Bienz, et al, *In Press*).

Baseline
Climatic water balance parameters with downscaled climate projections, and plant associations (Simpson 2007) were used to assess historical reference sites in the context of projected future climate and identify climate analog reference conditions (Churchill et al 2013). We compared the results from reference plots within Ponderosa Pine Plant Associations (Water Balance Deficit 216±2.3) to treatments (Bienz et al *in Press*), including fire only that establish aggregated trees (Franklin et al 2018), and provided over 15% of the landscape in openings (Table 1).

Implementation
Cooperation (e.g., jointly planning and implementing fire management) was the central focus to increase the economy of scale of operations and the collective impact of practices. TNC initiated

a cross-boundary fuels reduction Supplemental Project Agreement with the Fremont-Winema National Forest (March 28, 2017) for the Big Coyote Fuels Reduction Project 17-DG-10062765-705.

Table 1. Whole-stand structural characteristics for historic and treatment conditions. Basal area, spacing-based thinning prescriptions, and Rx fire severity in terms of agreement with reference conditions for dry pine forests.

Units	QMD (in)	Mean dbh (in)	Trees ac^{-1}	Basal Area (ft^{2-1})	SDI	% open	Water Deficit
Reference	22.4±1.6	20.1±1.8	32±2.3	84.9±7.1	125.3±8.0	17.4±1.2	216±2.3
Fire only	11.6±2.3	12.9±2.3	59±6.8	58±16.3	75±16.5	17.8±3.3	218±1.3
Treatments	17±2.0	14.7±0.2	47±5.6	73.9±12.3	114.4±15.4	13.5±0.8	214.4±7

Results

In 2017 and 2018, TNC hosted a collaborative training, education, research, and restoration-related event for two-weeks each year at Sycan Marsh Preserve in Oregon. During the training over 80 individuals participated and gained new skills. Cooperation (e.g., jointly planning and implementing fire management) reduced the cost from a projected rate of $170.88 per acre to $57.67 per acre. Project area increased by 27% over projected including areas considered higher risk. Through interagency/ inter-organizational participation in the shared learning and training experience cadre and scientists applied fire on over 3,000 acres in shrub-steppe and forested communities, crossing jurisdictional and administrative boundaries.

Our results have changed people's perspectives, methods and tools to implement fire treatments. Providing new skills and awareness has increased awareness and ownership in fire use, also measured through ecosystem services, and reduced risks of high severity fire. Despite the potential ecological and social benefits of cooperating on cross-boundary forest management, and over 18 years of prescribed fire treatments with resource monitoring and research we have found that such approaches are uncommon in practice among public and private land managers.

We have now expanded our methods to two other project areas in eastern Oregon (Lavell et al. 2018). We have identified two constraints in an all-lands approach. One issues in our area is with non-resident owners. Absentee landowners may be less likely to partake in community focused strategies. We have had to engage these individuals on a case, by case basis. Discussions have generally had positive results. Reorienting the landowners on their perceptions about the responsibility and risks of severe wildfire has been a focal point. As individuals become more aware we have observed an interest by private landowners toward a new path of sustainability and greater likelihood of success. Providing fire management coordinators within the local area may best serve the needs for cross-boundary implementation. Individuals in these positions best serve the landowners if they can relate to non-suppression related activities. There are existing policies that prevent private landowners from full participation in use of prescribed fire. Our longer-term strategy is to address these as policy issues (Leavell et al. 2018).

Discussion

Establishing cross-boundary fuel management projects with other landowners has become a necessity when land managers want to achieve multiple treatment and ecological objectives (improve forest conditions and reduce the wildfire risk to communities) on larger landscapes. Increasing the efficiency and effectiveness of silvicultural treatments is considered an important part of reducing the current scale of high-intensity and high-severity fire. There is evidence that treatments to return disturbance regimes (e.g. patterns of severity, frequency, and timing) along with historically novel disturbance events and disturbance interactions (Turner 2010; Trumbore et al. 2015, Stephens et al 2018) reduce risks of fire severity (Ager et al., 2015, Leavell et al. 2018) and resistance and resilience to fire and drought (Franklin and Johnson 2012; Hessburg et al. 2015; Stephens et al. 2018).

Our treatment objective developed uneven-aged, multi-aged, and single-tree selection silvicultural systems that integrated concepts from disturbance and landscape ecology with knowledge of stand dynamics and the need for heterogeneity (O'Hara 1998, Seymour et al. 2002, Mitchell et al. 2006, O'Hara 2014). Treatments produced a spatially heterogeneous pine-dominated forest consistent with a high-frequency, low-severity fire regime. Forest with higher percentage of open patterns provide heterogeneity in the fuels, which produced downwind effects and create areas of interacting firelines with changed rates of spread, residence times, and intensities compared to coherent firelines that show more consistent fire behavior. Such a forest should exhibit resistance to high-severity crown fire, drought, and disease; be positioned to adapt to future climate change; preserve options for future management and timber harvest; and sustain multiple ecological functions such as habitat for native biodiversity (Franklin and Johnson 2012, Hessburg et al. 2015, Franklin et al. 2018).

Forest treatments that establish complex forest patterns with trees aggregated have a higher mean clumping size. When prescriptions are developed in combination with climate analog reference targets, provides a practical approach to restoring spatial patterns where openings are a higher proportion of the landscape are likely to enhance resilience and climate adaptation.

We have found that landscape scale planning and implementation has been motivated by a local-to-national need for more prescribed fire. There is a profound need to increase field experiences, especially considering rapidly changing burn conditions strongly influenced by weather conditions. Providing fire managers with better skills and understanding of fuel conditions may save lives. Demonstrating the power of interacting fire lines for creating structural complexity, along with the absence of specific, scientifically-defensible guidance for burners is a needed skill. Our collaborative efforts with federal Partners and working in affiliation with scientists (The Desert Research Institute, University of Montana and The Nature Conservancy), capitalizes on a partnership between landowners in the Upper Klamath Basin, Oregon who share a common goal of expanding fire use to enhance forest resiliency and mitigate impacts of future wildfires (Leavell et al. 2018).

Fuels may be the keystone to sustain these resilient multi-aged complex forests. Incorporating the relationships among the parts of the system is a strategy needed rather than only the parts. We have seen benefits integrating multiple success factors into a logical and sequenced set of actions across the fireshed over time. Complex fuels should be considered into fire use at the appropriate scale including size, number, and total acreage of burned lands depend on: developing scientifically defensible techniques to allow burners to meet a broader range of conservation outcomes, increasing resources for planning, implementation, and monitoring, assessing human health impacts from emissions, and developing multi-scale administrative tools.

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