Identifying and Mitigating Social-Ecological Tradeoffs: Vegetation, Birds, Fuels, and Modeled Fire Behavior in Piñon-Juniper Fuel Reduction Treatments

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KEYWORDS—crown fire, invasive species, hydro-ax, *Juniperus monosperma*, *Juniperus scopulorum*, *Pinus edulis*

Mastication and hand-thinning treatments are increasingly used by land managers as a means of reducing tree cover for fire hazard mitigation and other habitat objectives in piñon-juniper (P-J) woodlands. (Battaglia et al. 2010; Redmond et al. 2013). However, the effects of these treatments on ecological processes including fire, and on a wide range of species, particularly vulnerable P-J obligate birds, are incompletely understood. To address these knowledge gaps, we measured vegetation and fuels, and conducted bird point counts at 232 sites in 29 pairs of 1 to 11-year-old treatments and untreated adjacent controls in P-J woodlands of the Arkansas River Valley, Colorado. We used a suite of statistical approaches including paired t-tests, mixed-effects models, and a principal component analysis to assess treatment impacts on vegetation composition and structure, bird abundance, fuels. We also used BehavePlus (Andrews et al. 2005) to develop fire behavior models to examine expected treatment impacts on fire behavior along gradients of fuel loads and under varying fuel moisture scenarios.

Treatments drove major, persistent ecological shifts relative to controls. Tree cover and canopy fuels were reduced; concomitantly, down woody surface fuels, forbs, and grass cover increased (Coop et al. 2017). Treatments exhibited rapid, large, and persistent increases in the frequency, richness, and cover of 20 non-native plant species including cheatgrass (*Bromus tectorum*). Exotic plant expansion was associated with reductions in tree canopy, alterations to ground cover (distribution of mastication debris and bare soil), and other treatment activities (Coop et al. 2017). Effective mitigation of nonnative species may necessitate additional pre- and posttreatment control measures. Decreased cover by piñon and juniper in treatments was also closely associated with reduced frequency of observations of a suite of P-J obligate bird species.

Reduced canopy fuels and increased herbaceous surface fuels, including exotic annuals, are expected to alter potential fire behavior through reduced active crown fire probability, but also increased surface fire intensity, flame length, and rate of spread. Modeled fire behavior suggests that under most conditions, treatments will be highly effective at reducing active crown fire risk, but also that treatments generally removed more trees than necessary to mitigate this risk. For example, average canopy cover was 6 percent in treatments but only 29 percent in untreated control units. However, even under fairly extreme 97th percentile conditions, models indicated that sustained

In: Malcolm, Karl; Dykstra, Brian; Johnson, Kristine; Lightfoot, David; Muldavin, Esteban; Ramsey, Marikay. 2020. Piñon-juniper habitats: Status and management for wildlife. Proceedings RMRS-P-77. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountian Research Station. 128 p.

active crown fire required greater than 30 to 50 percent canopy cover. Retention of more trees within treated sites will likely benefit P-J obligate birds. Fire behavior models also indicated that residual trees within treatment sites, particularly in masticated sites, were still highly susceptible to passive crown fire (torching), due to abundant surface fuels, increased flame lengths, and low tree crown base heights. Models, including simulated treatment modifications, suggest that this remaining crown fire risk could mostly be eliminated through follow-up surface fuel reductions (e.g., prescribed fire) and/or crown base height increases (e.g., pruning). We propose that managers consider additional posttreatment fuels interventions to increase the fire resistance of residual trees, which is anticipated to yield both social and ecological benefit. We encourage managers carrying out P-J fuels reductions projects to explicitly consider potential trade-offs between desired treatment outcomes and unintended ecological impacts, and how these might be mitigated. In areas distant from the wildland-urban interface, and in persistent P-J woodlands without imminent restoration needs, we also question whether or not tree removal treatments may be useful given anticipated climate change impacts to these woodlands (e.g., McDowell et al. 2016).

ACKNOWLEDGEMENTS

Funding was provided by the Joint Fire Science Program (13-1-04-45) and the Western State Colorado University Thornton Biology Research Fund.

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