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Economic Opportunities and Trade-Offs in Collaborative Forest Landscape Restoration

Alan A. Ager [a,*], Kevin C. Vogler [b], Michelle A. Day [c], John D. Bailey [b]

[a] USDA Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory, 5775 US Highway 10W, Missoula, MT 59808, USA
[b] Oregon State University, College of Forestry, Forest Engineering, Resources & Management, 043 Peavy Hall, Corvallis, OR 97331, USA
[c] Oregon State University, College of Forestry, Forest Ecosystems &Society, 321 Richardson Hall, Corvallis, OR 97331, USA

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ABSTRACT

We modeled forest restoration scenarios to examine socioeconomic and ecological trade-offs associated with alternative prioritization scenarios. The study examined four US national forests designated as priorities for investments to restore fire resiliency and generate economic opportunities to support local industry. We were particularly interested in economic trade-offs that would result from prioritization of management activities to address forest departure and wildfire risk to the adjacent urban interface. The results showed strong trade-offs and scale effects on production possibility frontiers, and substantial variation among planning areas and national forests. The results pointed to spatially explicit priorities and opportunities to achieve restoration goals within the study area. However, optimizing revenue to help finance restoration projects led to a sharp reduction in the attainment of other socioecological objectives, especially reducing forest departure from historical conditions. The analytical framework and results can inform ongoing collaborative restoration planning to help stakeholders understand the opportunity cost of specific restoration objectives. This work represents one of the first spatially explicit, economic trade-off analyses of national forest restoration programs, and reveals the relative cost of different restoration strategies, as well scale-related changes in production frontiers associated with restoration investments.

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1. Introduction

Restoration ecology has increasingly become a key component of land management programs on both public and private lands in many regions of the world (Adame et al., 2015; BenDor et al., 2015; Wilson et al., 2012). A case in point are the large scale forest restoration programs initiated on western US national forests under the Healthy Forest Restoration Act (HFRA, 2003) to improve the health and fire resiliency of dry forest ecosystems (Noss et al., 2006; USDA Forest Service, 2012). The programs encompass a multitude of ecosystems and services with focal points on resiliency of landscapes to fire, watershed condition, invasive species, and wildlife habitat. Fire resiliency objectives are achieved through fuel management projects that use forest thinning, prescribed fire, and a range of other techniques aimed at returning fire frequent forests to pre-settlement conditions (Agee and Skinner, 2005; Brown et al., 2004). The HFRA was broadened with the Omnibus Public Land Management Act of 2009 (Title IV) which established the Collaborative Forest Landscape Restoration Program (CFLRP, USDA Forest Service, 2016b) to encourage science-based planning and promote diverse restoration approaches to meet broad ecological, economic, and resource protection objectives (Butler et al., 2015). Key outputs from the restoration program include commercial wood supply to private entities to offset restoration treatment costs and employment opportunities in rural economies (USDA Forest Service, 2016b). The science dialog around the program has been extensive, and includes discussions of ecological goals (Brown et al., 2004; Haugo et al., 2015; Moore et al., 1999; Noss et al., 2006), planning frameworks (Butler et al., 2015; Franklin and Johnson, 2012; Schultz et al., 2012; USDA Forest Service, 2016b), implementation strategies (Rieman et al., 2010), economic assessments (Rasmussen et al., 2012; Rummer, 2008), and human dimensions (Franklin et al., 2014; Payne, 2013). A recent five-year review of the CFLRP (USDA Forest Service, 2015) and a national conference of managers and stakeholders highlighted local implementation of the program and results from specific restoration projects.

Ongoing implementation of the restoration programs and inclusion of diverse stakeholder groups in the planning process has challenged federal land managers to better articulate priorities and desired outcomes from the program (Butler et al., 2015). Under the current process, local forest managers in concert with stakeholder groups attempt to blend local values with broad regional assessments of restoration

* Corresponding author.
E-mail addresses: aager@fs.fed.us (A.A. Ager), kevin.vogler@oregonstate.edu (K.C. Vogler), michelle.day@oregonstate.edu (M.A. Day), john.bailey@oregonstate.edu (J.D. Bailey).

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needs under national policy direction. The analytical component of current collaborative planning efforts largely consists of ad hoc analysis of spatial data from regional and local assessments coupled with field observations to determine site specific projects and planning areas (Butler et al., 2015). Guidelines and analytical protocols to prioritize restoration planning areas based on singular or multiple goals (Neeson et al., 2016), including economics (Adame et al., 2015; Kimball et al., 2015), are nonexistent. Nor are analyses conducted to evaluate trade-offs among economic aspects and the reduction of stressors (Allan et al., 2013; Bullock et al., 2011; Maron and Cockfield, 2008) that potentially adversely impact forest health and resiliency. The trade-offs in restoration activities stem from finite budgets, operational capacity, and spatial variation and covariation across different restoration targets (Anderson et al., 2009; Martin et al., 2016; Neeson et al., 2016). The net result is that stakeholders participating in collaborative restoration planning are not fully informed about the opportunity cost of emphasizing one restoration objective over another. Moreover, trade-offs are not considered in strategic assessments of restoration need because they either generally have a singular objective (Haugo et al., 2015; Rasmussen et al., 2012; USDA Forest Service, 2011) or the coarse scale of assessment inputs precludes analysis at the project implementation scale (Barbour et al., 2008b; Rasmussen et al., 2012). Thus spatial priorities and targets established by regional assessments to address specific socioeconomic and ecological issues, including wood supply (Barbour et al., 2008a), fire protection to the wildland urban interface (WUI, Bailey, 2013), and ecological departure from historical conditions (Haugo et al., 2015) ignore trade-offs, and may well suggest unobtainable or non-optimal outcomes. Scale effects on production functions (King et al., 2015) and scale mismatches (Cumming et al., 2006) between assessments and project implementation can also contribute to a decoupling of restoration policy goals with actual implementation in the field. Clearly, integrating economic and ecological trade-off analyses could provide manifold improvements to the current planning efforts, especially with respect to the primary goals of sustaining rural economies and meeting fire resiliency objectives in fire prone, forested areas. For instance, economic analyses can pinpoint locations where treatments can generate revenue that in turn can be used to subsidize non-economic fuels mastication and thinning treatments elsewhere within planning areas, thereby maximizing the total area restored for a given level of financial investment.

In this paper we describe a detailed analysis of economic and ecological trade-offs within four US national forests (NF) designated as a national priority for restoration (USDA Forest Service, 2016a). We first examined how generating revenue from restoration affected opportunities to address social and ecological goals within 102 individual planning areas. We then examined cumulative net revenue realized from specific restoration targets over increasing scales of implementation. Of specific interest was the idea that maximizing revenue could help facilitate building large fire resilient landscapes by subsidizing treatment of forest stands that cannot produce economic benefits, but require fuels treatment for fire resiliency objectives. We use the study to stimulate a discussion about ways to improve stakeholder engagement in the prioritization of restoration projects as part of collaborative planning (Butler et al., 2015) via the use of production frontiers (Cavender-Bares et al., 2015; King et al., 2015) (Fig. 1).

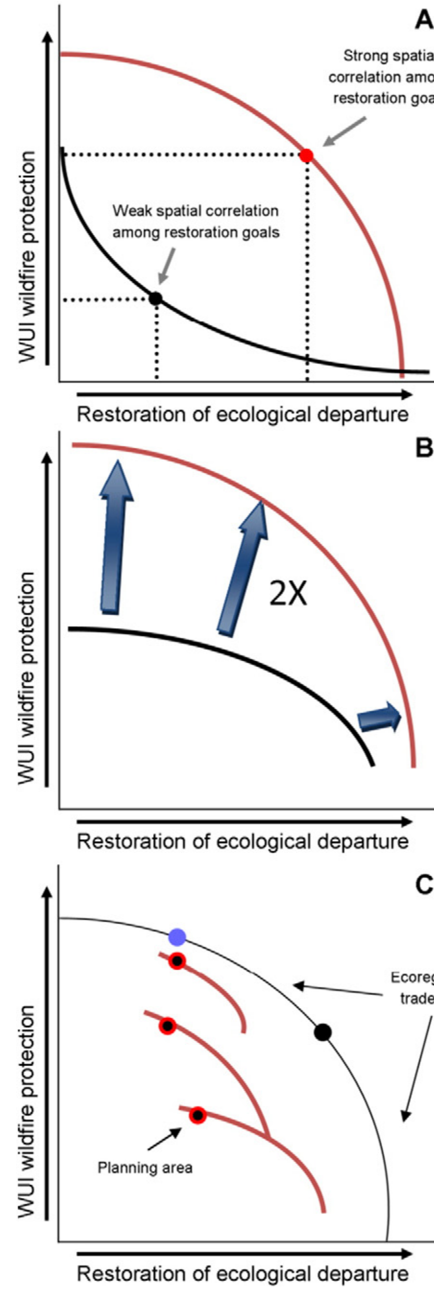

Fig. 1. Example production possibility frontiers (PPFs) for US federal forest restoration programs. A) PPFs showing convex to the origin (black line) versus concave to the origin (red line) production relationships between two restoration goals achieved through forest management activities. Strong spatial correlation among different restoration treatment goals makes it possible for joint, optimal attainment (red dot). When spatial correlation of restoration targets is weak, joint attainment (black dot) results in significantly less progress towards multiple restoration goals, and sharp declines in the potential treatment of each goal individually. B) Possible change in PPF from additional investments in restoration where the production frontier becomes asymmetrical due to the scarcity of stands requiring treatment for one of the objectives (ecological departure) but not the other; C) example where local collaborative groups select projects for implementation for planning areas within individual national forests (red circles) but local preferences result in suboptimal production at the ecoregional scale (blue circle) or are not preferred by policymakers (versus optimal production, black circle). WUI = wildland urban interface. Panel C adapted from King et al. (2015).

2. Methods

2.1. Study Area

The study area encompassed four national forests (Malheur, Ochoco, Umatilla and Wallowa-Whitman) in the Blue Mountain ecoregion (USDA Forest Service, 1994) of eastern Oregon and southeastern Washington and includes 2.5 million ha of forest and rangelands (Fig. 2). The area is interspersed with small mountain ranges, canyons, and plateaus. Elevations generally range from 900 m to 1500 m, with higher peaks close to 3000 m. Dry forests of ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson) dominate lower elevations, with dry mixed conifer (grand fir (*Abies grandis* (Douglas ex D. Don) Lindl) and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco)) at higher elevations. Cold dry