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Restoration for Multiple Use

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INVITED STRATEGIC ARTICLE

Restoration for multiple use

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Management of restored ecosystems for multiple use is a modern necessity given a growing human population and dwindling supplies of ecosystem goods and services. Multiple use management refers to managing resources simultaneously for sustainable output of many goods and services. Within any restoration, thoughtful planning and early stakeholder engagement can help harmonize seemingly competing multiple uses. Although the field of ecological restoration is young and there are few long-term lessons to draw from, we can infer from ecological theory that maximization of native biodiversity can impart resilience in the restored ecosystem and can buffer against the stress of multiple use management. Restoration for multiple use should be accompanied with an acknowledgment that humility is required and monitoring is needed to keep the restored ecosystem on an acceptable trajectory. The field of ecological restoration was founded upon the notion that ecosystems would be restored for ethical reasons, but modern realities have necessitated a more utilitarian approach to restoration that requires restoring ecosystems for multiple uses. This reality represents a grand challenge for the next generation of restoration ecologists.

Key words: **biodiversity, ecosystem goods, ecosystem services, resilience, stakeholder engagement**

Implications for Practice

- Current realities of a human-dominated planet dictate that we must restore ecosystems that can provide multiple goods and services to humans.
- Early and sustained engagement of all stakeholders is crucial for restoring ecosystems for multiple use.
- Ensuring that restored ecosystems are heterogeneous and have high diversity of native species can impart resilience required for sustainable multiple use.

Introduction

Concern for obtaining multiple goods and services from our environment is likely as old as our species. Our biological origins as hunter-gatherers necessitated a broad awareness and wise utilization of natural resources. Therefore, *current* paradigms of managing forests, rangelands, agricultural lands, urban areas, and aquatic and marine environments for multiple use is not a new concept for our species. However, now that our species has crossed the threshold of 7.6 billion individuals, there is a mounting urgency to maximize output from the dwindling natural resources remaining on our planet. We no longer have the luxury of managing ecosystems for one or few natural resources; all ecosystems must now be managed to provide a sustainable output of many goods and services. This mounting urgency has, in many cases, led to degradation of our environment. This is why the emerging field of restoration ecology has been described as critical for the future of our planet (Roberts et al. 2009).

Optimizing Ecological Restoration for Multiple Use

"Multiple use management" of natural resources is an established paradigm in fields such as forestry, rangeland management, and, more recently, management of marine habitats. Multiple use management refers to managing resources simultaneously for sustainable output of many goods and services such as water, timber, forage, food, recreation, and biodiversity, among others. In the United States, this management paradigm emerged as policy within federal agencies tasked with managing vast tracts of western public lands during the late 1800s and early 1900s. During this period there were many competing demands on these lands including timber, livestock, wildlife harvesting, mining, and water for growing urban areas and farms (Alexander 1987). These competing demands led to tension, violence, and a great deal of political strife that continues to this day. As a result of these tensions, land management agencies adopted multiple use management strategies to balance sustainable utilization of the limited resources among competing demands.

By the time the young fields of ecological restoration and restoration ecology emerged in the latter half of the twentieth century, multiple use was firmly entrenched in many land management mindsets. However, since ecological restoration was initially viewed as returning an ecosystem to a past state largely free of human impact, utilitarian ideas of multiple use of restored ecosystems were largely shunned. Recently, a more human-centric and forward-looking view of ecological

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Figure 1. The Uncompahgre Plateau in Colorado, U.S.A. (top panel), was subject to long-term fire suppression that led to a decline in forest health and uncharacteristic fire behavior. To address needs for restoration, the U.S. Forest Service partnered with a large and diverse group of local stakeholders to form a Collaborative Forest Landscape Restoration Project with the goal of enhancing the resiliency, diversity, and productivity of the landscape. The project has been highly successful due to the early engagement of stakeholders (lower left panel) and restoration project monitoring by stakeholder groups and local school groups (lower right panel) (Photos by T. Cheng).

restoration has emerged that embraces human needs (Higgs et al. 2014). Still, the field of restoration ecology only implicitly acknowledges multiple use as an outcome of restoration projects. For example, the Society for Ecological Restoration (SER) International Primer on Ecological Restoration does not include multiple use as a desired attribute of restored ecosystems (SER Primer), but multiple use may be implied in the SER standard number 5 that suggests restoration projects should be "culturally embedded" (SER Standards). Multiple use also is implied in the guiding principle number 4 proposed by Suding et al. (2015) that restoration should benefit and engage society. We contend that multiple use should be more than implied in restoration; it should be an explicit goal from the outset.

Sustainable output of multiple goods and services from restored ecosystems involves careful planning of restoration projects. Such planning requires that multiple stakeholder groups, each promoting a single or a few interests or competing demands from the landscape, is engaged during restoration planning. Such engagement ensures that all interests have buy-in to the restoration project and ideally will bring resources and stewardship to the project to ensure success (Fig. 1). An additional benefit of stakeholder engagement in restoration is the potential to enlist stakeholders for post-restoration monitoring.

However, in reality the challenges of balancing multiple stakeholder interests with technically sound ecological restoration projects are tenuous. We know little about the long-term efficacy of restoration projects that are subject to multiple use management. We can surmise that a continuous flow of goods and services from restored ecosystems requires sustainable levels of use of those goods and services. We also know that ecosystem sustainability and ecosystem resilience are inherently linked to biodiversity.

Biodiversity as a Guiding Principle in Restoration for Multiple Use

Most restoration projects strive to promote biodiversity for a variety of reasons. One benefit of restoring ecosystems with high biodiversity as a goal is a greater degree

Figure 2. Mobile cattle corral (left) intentionally placed in a degraded area to fertilize and seed bare ground (right) and create nutrient hotspots in this African savanna landscape. The restoration approach aims to simultaneously address two restoration goals: (1) creation of highly productive areas to maximize grass production for cattle forage and (2) establishment of nutrient-rich patches that serve as wildlife hotspots (Photos by L. Porensky [left] and K. Veblen [right]).

of resilience in the face of the potentially greater stressors associated with multiple use. Ecologists have long recognized that biodiversity in ecosystems imparts higher productivity and resilience (speed of recovery after a disturbance), and these concepts have become two of the most widely held assumptions in vegetation science (Schultze & Mooney 1993). For example, a recent analysis of 1,126 grassland study plots across five continents revealed a strong and consistent link between productivity and species richness (Grace et al. 2016), and numerous studies have demonstrated that productivity of diverse grassland plant communities is more resistant and resilient to drought than species-poor communities (e.g. Tilman & Downing 1994; Wagg et al. 2017). Driven by concerns over species extinctions and climate change, many recent studies are further examining these assumptions and finding that recovery of productivity in plant communities after extreme climate events is strongly dependent on initial plant community diversity. For example, a meta-analysis of 46 experiments where grassland plant community diversity was manipulated concluded that biodiversity was especially important for stabilizing ecosystem productivity after extreme climate events (Isbell et al. 2015). These well-established concepts in ecology suggest that restoration efforts should strive to maximize biodiversity in order to avoid restoration failures resulting from extreme climate events and to provide resilience to disturbance associated with multiple uses. Undoubtedly, several added benefits of promoting biodiversity in restored ecosystems include value to wildlife, insect pollinators, aesthetics, and other multiple use objectives.

Active Management and Monitoring Are Needed in Multiple-Use Restored Ecosystems

The greater potential for competing or conflicting goals, as well as the greater diversity of stressors and disturbances associated with sustaining (and restoring) multiple uses, make active management and monitoring of restoration success particularly important. Harmonizing these competing goals may be a delicate balance, and there are a number of scenarios in which progress toward multiple goals may be at odds with one another. For example, in multi-use rangelands, restoration efforts to maximize herbaceous production for livestock production may lead to the establishment and dominance of highly productive and palatable plant species for livestock (Fig. 2). However, this could result in a low-diversity plant community that precludes simultaneously meeting a goal to improve wildlife habitat. Alternatively, restoration activities could successfully establish habitat that attracts wildlife that consume the most productive or palatable plants, leaving insufficient forage for livestock (Fig. 2). In these scenarios, adaptive management actions such as additional restoration effort to alter plant community composition, reconsideration of target restoration species, or intensive management of herbivory at the restoration site, may be necessary. Such actions will be most effective for optimizing among multiple goals if restoration trajectories and problems are detected early in the restoration process. Early detection and intervention are necessary because, with an increasing number of simultaneous goals/uses in a restoration, comes the greater possibility of complex interactions among different players and potentially unexpected outcomes. Moreover, monitoring efforts can be coordinated among different players to increase cost-effectiveness of monitoring and foster communication and coordinated management. However, monitoring (or lack thereof) is a perennial problem in natural resource management and restoration (Bernhardt et al. 2007; Kiesecker et al. 2007; Kettenring & Reinhardt Adams 2011; Veblen et al. 2014) and must therefore be deliberately prioritized—and we would argue that it is even more important to do so in multiple use scenarios.

Conclusion

Due to ever increasing demands on natural resources, multiple use management of ecosystems is here to stay, and the field of ecological restoration will need to adapt to this emerging reality. With increasing utilization of all ecosystems, human managers will be faced with repairing degraded ecosystems, and the practice and principles of ecological restoration will be crucial for the survival of our species. In order to meet these challenges, we suggest that multiple use should be an explicit goal of restoration projects and that restoration projects should strive to promote native biodiversity as an underlying goal within the necessary framework of multiple use management. Given the complexities of restoring ecosystems that will be managed for multiple uses, it is imperative that monitoring and adaptive management are part of that framework. Combining ecological restoration with multiple use management is a grand challenge for the field of ecological restoration. In 1984, Tony Bradshaw famously declared that "[l]and restoration is the acid test of our ecological understanding" (Egan 2001). We assert that restoration within a framework of multiple use management will be the future acid test of the emerging field of ecological restoration.

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