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# Rehabilitating Yosemite's Wet Meadows

## Introduction

The unique characteristics that belong to Yosemite's meadows have allowed for the development of ecologically diverse pastures filled with a wide variety of organisms. These unique assemblages of plants and animals are often endemic to each meadow. Though meadows only make up about 1% of the Sierra Nevada mountain range, we cannot forget how imperative they are for biodiversity, flood retention, stream health, and most importantly for the average visitor, glorious vistas. According to the California Region's basic range type classification system (1969), there are three major types of meadows: wet, dry, and semi-wet. The focus of this paper is the wet meadows in Yosemite National Park. Below, I discuss methods to rehabilitate Yosemite's native wet meadows that have been so vastly altered due to past anthropogenic activities.

## Background

Yosemite's pristine wet meadows have drastically changed due to the introduction of non-native species, grazing by large packstock, and the regulation of fires. Originally, the wet meadows were dominated by perennial wildflowers, such as blue lupines and yellow butterweeds; sedges, grasses, and woody willow shrubs also coexisted with these wildflowers (Epke et al 2010). Trees were naturally absent from these wet meadows due to the perennial inundation; the lack of oxygen in the wet soil makes it biologically impossible for trees to survive. The niches created by the various plant species and inundated pools make these wet meadows biodiversity hot spots for many endangered species, including the Yosemite toad and Great grey owl (USEPA 2007). These hot spots have become limited though, due to a largescale introduction of grazing animals in the late 1800s.

The distinct habitats created by Yosemite's unique hydrology were severely altered primarily due to grazing by large non-native animals such as sheep and horses (Holmquist 2013). Grazing allowed for habitat patchiness to develop, which functionally fragmented the plants and created habitat loss at the larger scale (Wettstein & Schmid 1999; Wiens et al 1985). In addition, grazing created an overall soil deterioration and compaction, resulting in a reduced water holding capacity. The hydrologic disturbances that were created by heavy grazing in the past has allowed for a facilitated invasion of non-native species.

Invasive species have played a significant role in the alteration of Yosemite's wet meadows. European annual grasses were introduced to the meadows where they easily outcompeted the native perennials (Holmquist et al 2013). The introduced grasses have many advantageous traits including early development and fast recovery from disturbances, allowing for an easy race against time alongside the native species (Epke et al 2010). Encroaching trees and shrubs can also be considered invasive, because they were not naturally present in the meadow's wet conditions. Mature trees can easily take away large amounts of water from the

native wetland species that thrive on the high soil moisture. The more recent regulation of fires has played a role in aiding the invasion of non-native annuals and shrubs.

Ground and surface fires are a native characteristic to Yosemite's meadows due to the high frequency of lightning in the high elevations (Debenedetti 1979). In addition to these natural fires, Native Americans would frequently burn the fields, maintaining an open shrub-free condition for many years (Vale 2013). Fires benefitted the meadows in a number of ways including preventing encroachment and limiting invasive fire-prone species. The native fauna have special adaptations that allow them to survive low intensity fires, increasing their survival rate over non-natives.

**Restoration Efforts in Yosemite**

According to the USEPA (2007), various conditions indicate that there has been an overall increase in instability and reduction of habitat quality in Sierran meadows since the 1950s. Without preventing further anthropogenic effects, establishing proper restoration and management could be devastating to the native floral communities (Wallace & Crosthwaite 2005; Purdy et al 2011). Many factors are to blame for the deteriorating plant and animal communities including herbivory, encroachment, and fire suppression. However, the main rehabilitation methods put into practice revolve almost exclusively around grazing management.

Certain plant assemblages, such as those adapted to wet versus dry soil environments, are less likely to survive in the compacted soils that result from grazing (Holmquist et al 2013). Therefore, the type and number of animals present must be closely watched in order to ensure the success of wet meadows. The number of introduced animals allowed on the wet meadows must be limited, since they can easily do more damage to the wet soil and vegetation than smaller, native herbivores. Light grazing performed by elk and deer, for example, is a native characteristic of Yosemite's meadows, and therefore should be encouraged (Holmquist et al 2013). Loomis et al (1991) pointed out that large herbivores, bigger than mule deer, were historically absent from the montane meadows of the Sierras. If any remaining large invasive herbivores can be removed, and native herbivory encouraged, the likelihood of faunal success might increase. In addition to grazing management, other efforts can be completed to stop encroachment by trees and other invasive species.

Encroachment has become an increasing issue, especially by white fir and red fir in certain areas, due to the widespread ban of fires (Liang 2013). In order to rid the meadows of invasive species, including introduced annuals and encroaching trees, physical removal and/or tillage could be completed in the extremely disturbed areas. Another possibility is to increase planting of native shrubs and grasses in order to encourage their chance of survival amongst the young encroaching trees. An alternative option is to manually apply an herbicide targeted only on the invasive species. The most affected areas in the meadows could be sprayed and then replanted with native species as needed. Finally, low intensity fires, as is natural to the meadow, could be utilized to remove larger woody shrubs and small trees.

Allowing natural ground fires to occur frequently would benefit the native species adapted to the natural fire regime. Invasive species and encroaching trees that are not adapted to the fires would likely die off at a young stage, allowing for more space and nutrient availability for the native community. Fires are also known to rejuvenate natural processes, such as the cycling of nutrients, which can benefit the ecosystem as a whole through the reintroduction of

necessary organic compounds (Liang 2013). The USEPA (2007) found evidence that intense but rare wildfires can damage the native community far more than small, frequent fires. Since these wet meadows are so moist, the fires are unable to get to quite as high intensity as upland areas, further implying that frequent burnings could be appropriate (Sugihara 2006).

## Conclusion

There are many methods and practices available for use in rehabilitating Yosemite's wet meadows. It is important to implement rehabilitation methods for Yosemite's beautiful wet meadows in order to preserve the unique biodiversity dominated by endemic organisms. In order to rehabilitate the native conditions, or at least improve upon them, a better understanding of the associations between the soil, water, plant, and animal continuum is needed (Roche et al 2014). Until these connections are made however, invasive herbivory can be limited while native herbivory is encouraged, encroachment of upland species can be limited, planting of native floral assemblages can be achieved, and natural ground and surface fires can be reintroduced. A primary goal in a broader sense is to maintain the heterogeneity that was native to the meadows so many years ago. In order to do this, the habitat complexity remaining must be preserved, and the disturbed zones must be improved. A complete restoration to pre-grazing conditions may be infeasible, but better management methods and practices that maximize native productivity can be established.

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