

HISTORY AND VULNERABILITY OF MEADOWS IN THE SIERRA NEVADA

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Abstract: Although meadows occupy only a small proportion of the Sierra Nevada landscape, they contribute disproportionately to current watershed services, ecosystem productivity, species diversity, cultural and recreational functions, and have often been the focus of wilderness legislation. Understanding the vulnerability of meadows to change is therefore a central theme for land management plans, but to evaluate vulnerability one must first understand the past and current processes that influence meadow creation and persistence. Meadows are generally characterized by surface water and/or shallow groundwater, fine textured soils which sometimes contain significant amounts of organic matter, and herbaceous plant communities with woody species sometimes locally abundant. Meadow characteristics are largely dictated by hydrological processes controlled by geomorphology which affects soil formation and the amount of surface and sub-surface water and the duration of seasonal saturation or inundation. Although geomorphology changes at geologic timescales, hydrology can vary over much shorter time periods. Most current meadows exhibit evidence that they were at or above timberline, highly erosional, and likely possessed sparse vegetation during the 100,000 year long Wisconsin Glacial Episode. Beginning about 10,000 ybp conditions became warmer and more favorable for plant growth, erosion rates declined and aggradation of mineral sediments and organic material increased, soils developed, and they became mostly forested with willow and sedges in areas of shallow ground water. Beginning approximately 2,500 to 1,200 ybp, neoglacial conditions have included periods of high winter snowpack, late season melting, and high summer water tables which caused tree mortality and retreat of forest ecotones to drier and more upland soils. Thus, by the definition of meadows presented above, most meadows have only existed in the Sierra Nevada for a few thousand years. Future climate warming and earlier snowmelt may recreate earlier Holocene conditions that favor woody species over herbaceous species in meadows. However, the relative vulnerability of meadows to these changes likely varies based on their specific geomorphologic and hydrologic characteristics. An effort is currently underway to assess the hydrologic vulnerability of the 9,000+ meadows in the NPS Sierra Nevada Network and determine the specific risk of each meadow to climate change. This effort utilizes a large database of climate forecasts and biophysical factors, especially Landsat imagery which is being used to characterize seasonal fluctuations in meadow wetness and greenness to infer their underlying hydrologic drivers. Although vulnerability of meadows to climate change is of fundamental concern, vulnerability to other landscape scale stressors such as nitrogen deposition and other pollutants should also be evaluated. Local stressors such as land use factors, species invasions, and disease are additionally important to consider since they are typically more amenable to land management actions.