Chaparral Thinning Reduces Burn Severity at the Expense of Soil Function in California's Wildland Urban Interface (WUI)

California Fire Science Consortium
"Informing Our Future With Fire"

Research Brief • May 2026

MANAGEMENT IMPLICATIONS

- Soil organic carbon, nitrogen, phosphorus, potassium, and pH were significantly higher at HBS sites than LBS sites in the first year postfire but converged by the second year.
- There was a global shift in bacterial species composition (β-diversity) between HBS and LBS sites over a period of 4.25 years following the Woolsey Fire.
- HBS sites showed an abrupt increase in Actinobacteriota at the expense of Bacteroidota (two bacterial phyla) 2.8 years postfire, whereas LBS sites maintained relatively stable phyla abundance over 4.25 years (Fig.1A).
- Management strategies should incorporate active control of invasive species in thinned areas, which should help support natural plant and soil microbial community succession in the chaparral.

Since the 1990s, California has experienced the greatest expansion of the Wildland-Urban Interface (WUI) within the United States and now contains the largest absolute number of WUI residents (Greenberg et al. 2024). As of 2022, 6.74% of California's total land area is classified as WUI. Concurrently, climatic trends have increased the frequency of fire-weather 2.5-fold in California, while WUI expansion has led to a 4.1-fold increase in extreme wildfire events from 1990 to 2022 (Kumar et al. 2025). A widely supported management strategy in the WUI to mitigate fire damage to homes is the creation of defensible space by mechanical thinning of native vegetation to reduce fuel-loads. In southern California, most effective thinning-distance from structures vary between 5 and 20 m (16–58 ft), while distances exceeding 30 m (100 ft) provide no additional protection, even for structures located on steep slopes (Syphard et al. 2014). Here we report on the negative impact of chaparral thinning on ecological soil function, with implications for limiting mechanical-thinning-distance to 30 m or less (Syphard et al. 2014). Additionally, excessive thinning of chaparral vegetation can promote conversion to exotic annual grasslands within the WUI (Syphard et al. 2019). These exotic annuals act as fine fuels that increase fire spread rates and promote fast-moving, surface fires typically associated with low burn severity (Pratt 2022). The natural experiment reported on below (Macias et al. 2025) was facilitated by the Woolsey Fire of November 2018, an extreme wildfire event as defined by Kumar et al. (2025), in the Santa Monica Mountains of southern California encompassing nearly one-half of the mountain range. We compared ecological soil function between Low Burn Severity (LBS) sites that underwent annual thinning of woody chaparral shrubs adjacent and High Burn Severity (HBS) sites in the WUI devoid of shrub thinning. We found that the Woolsey Fire generated a 4.5-fold higher burn severity at HBS sites than at LBS sites. We then compared postfire soil nutrients, soil pH, soil respiration, and soil bacterial dynamics between HBS and LBS sites to elucidate potential differences in ecological soil function within the WUI.

Soil organic carbon, nitrogen, phosphorus, potassium, and pH were significantly higher at HBS sites than LBS sites in the first year postfire but converged by the second year. The initial difference was presumably due to higher fuel loads and residual ash at HBS sites. The subsequent convergence of nutrients between sites was presumably due to rapid assimilation of soil nutrients by ephemeral fire-followers at HBS sites (postfire endemics), as described by Rundel & Parsons (1984). We identified a global shift in bacterial species composition (β-diversity) between HBS and LBS sites over a period of 4.25 years following the Woolsey Fire. Bacterial richness and distribution (α-diversity) was lower at HBS sites than LBS sites from May 2019 through July 2021. These global shifts in diversity were likely driven by an abrupt increase in Actinobacteriota at the expense of Bacteroidota (two bacterial phyla) in the HBS sites 2.8 years post-fire (Fig. 1A). Conversely, LBS sites maintained stable phyla abundance over 4.25 years (Fig. 1A). We speculate that the difference between sites was the lack of postfire succession of fire endemics and reestablishment of chaparral seedlings at LBS sites in contrast to HBS sites. At the genus level, there were greater temporal fluctuations in bacterial abundance at HBS sites compared to LBS sites (Fig.1B). Of note, in the 4.25 years post-fire, these compositional differences in the HBS sites are accompanied by a reduced metabolic capacity of the bacteria in HBS soil. These enhanced fluctuations likely resulted from dynamic turnover of short-lived fire endemics at our HBS sites that survive only a few years after fire before returning to soil seed banks as dormant propagules, waiting for the next fire event to germinate, often stimulated by chemical cues, such as smoke from wildfire (Keeley and Fotheringham 1998).

Altogether, these findings suggest that thinning of woody chaparral shrubs to generate defensible space in the WUI not only change endemic vegetation and its succession after wildfire, but also reshape soil microbial communities by altering typical bacterial succession and function after wildfire. Therefore, management strategies should not only limit thinning to the recommended maximum distance of 30 m from human structures but also incorporate active control of invasive species in thinned areas. Integrating best defensible space practices with invasive species management will be critical to reducing long-term chaparral degradation and maintaining ecosystem resilience in California's rapidly expanding WUI.

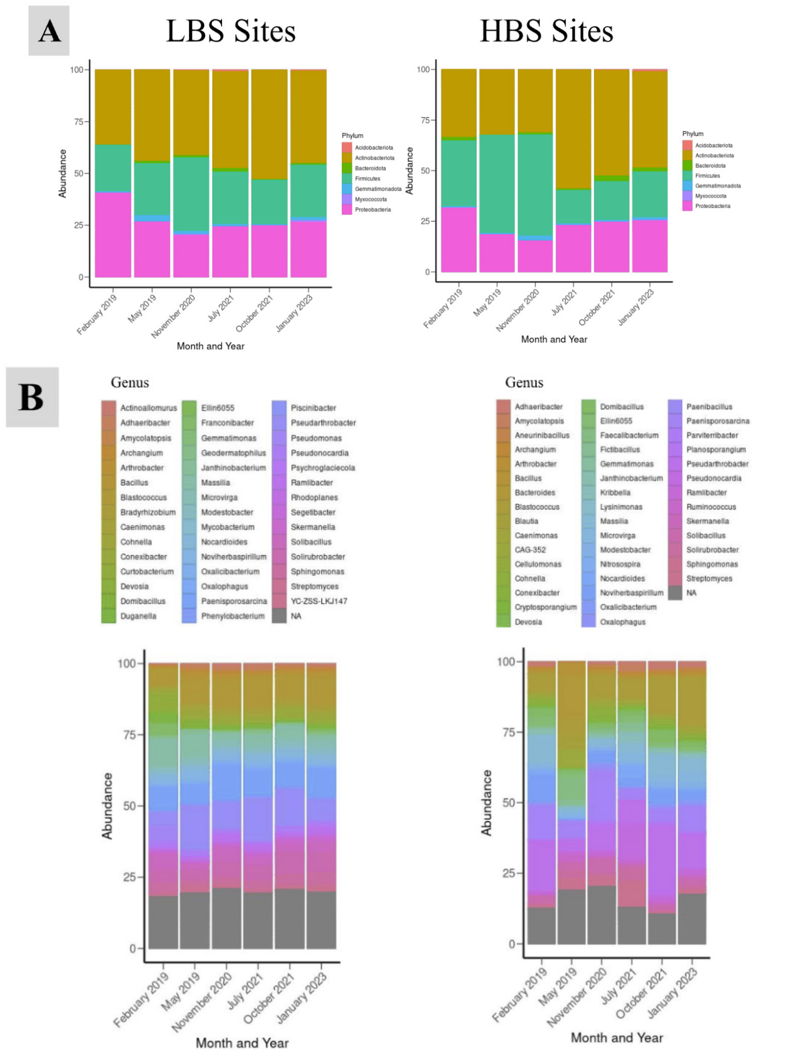

Figure 1: A) Soil bacteria comparisons of phylum abundance between Low Burn Severity (LBS) and High Burn Severity (HBS) sites in a Wildlife Urban Interface of the Santa Monica Mountains of southern California. B) Soil bacteriome comparisons of genus abundance revealed enhanced dynamic fluctuations over time at HBS sites compared to LBS sites.

Additional Information

This brief is based primarily on the following article:
Macias, M., Irving, M.R., Bandow, K.M., Kim, K., Heredia, C., Hoskinson, C.A., Duchild, N.R., Nicholas, M.T., Marian, L.M., Sicangco, C.K., Smith, K.L., Davis, S.D., Holmlund, H.I. and Stiemsma, L.T. 2025. Effects of low wildfire burn severity due to pre-fire shrub thinning on the chaparral soil bacteriome in the Santa Monica Mountains of Southern California. Microbiology spectrum, 13(8), pp.e00185-25. https://journals.asm.org/doi/full/10.1128/spectrum.00185-25

This brief was written by Stephen D. Davis, Leah T. Stiemsma, Helen I. Holmlund, and Karagan L. Smith, reviewed by Autym Shafer, and produced by the CFSC Central and Southern California Region

Additional Readings and Citations can be found: https://www.cafirescience.org/research-publications-source/soilfunctionwui

For additional information, contact: cafirescience@gmail.com