## Research Brief for Resource Managers

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# Bet-Hedging Desert Restoration Practices during Drought

*Rader, A.J., L.P. Chiquoine, J.F. Weigand, J.L. Perkins, S.M. Munson, and S.R. Abella (in press). Biotic and abiotic treatments as a bet-hedging approach to restoring plant communities and ecological functions. Restoration Ecology. doi: 10.1111/rec.13527*

Ecological restoration practices effective during drought conditions are likely to become increasingly needed in current and future climates. Directly reintroducing plant propagules, such as through seeding or outplanting nursery-propagated plants, is capable of rapidly revegetating disturbed desert sites but is prone to failure especially during adverse climatic conditions. An alternative approach is using cheaper abiotic treatments designed to enhance favorability of site conditions, including for natural plant recruitment. On four disturbed sites in the Sonoran Desert of southeastern California, we simultaneously compared outplanting with two abiotic treatments (Fig. 1) as a bet-hedging approach to achieve restoration benefits even if some treatments failed.

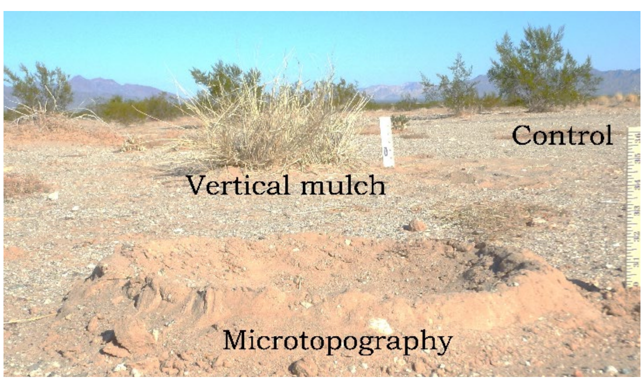


*Fig 1: Examples of microtopography and vertical mulch restoration treatments on a disturbed site, Bureau of Land Management land, Palm Springs District Office, CA.*

## Management Implications

- Outplanting has restored native perennials in a variety of drylands, but during droughts when infeasible plant care may be required, practitioners could consider using abiotic treatments as substitutes for live plants to restore ecological functions.
- Vertical mulch using dead plant material is promising for inexpensively initiating recovery in drylands, including during droughts when seeding or outplanting is difficult.

The growing season (November 2017-March 2018) in which restoration treatments were implemented had the driest conditions in the last 47 years (Fig. 2). Despite some irrigation and protection, all 144 outplants of three native perennial species were dead within three months.

Meanwhile, some of the abiotic treatments showed promising signs of promoting ecosystem function, even in the drought conditions. The abiotic treatment of vertical mulching (placing dead plant material upright in soil) showed increases in shrub seedling cover and species richness even more so than in plots receiving a microtopography treatment and in untreated controls. Furthermore, vertical mulch reversed soil erosion, which was a serious problem on the four disturbed sites which experience high winds and were sources of fugitive dust, also likely lowering future site productivity potential due to soil loss. Over 16 months, vertical mulching increased the soil accumulation rate by 6 times compared to the untreated control sites (Fig. 3). While the second abiotic treatment (constructing microtopography) accumulated more soil than the control (which lost soil), a negative tradeoff of microtopography was that it increased cover of non-native plants. These non-natives included those that can produce fuels for wildfires.

Overall, results revealed three main findings: (1) inexpensive, minimal-input abiotic treatments outperformed resource-intensive biotic treatments; (2) the restoration effort withstood the total failure of a major component (outplanting) to nevertheless achieve key restoration benefits within 2–3 growing seasons; and (3) incorporating multiple treatment types served as a bet-hedging approach to buffer against treatment failures.

In addition to helping inform the critical practical decision of treatment selection for restoration during drought, results also can guide further questions and research on a general question in restoration ecology. One such question is how well abiotic structures serve as functional substitutes for foundational live organisms, such as trees in forests or fertile-island forming perennials in deserts. In deserts, the relative functional benefits of biotic versus abiotic structures are likely to hinge on differences stemming from numerous processes, such as trapping of windblown soil, precipitation throughfall and shading, litter deposition, faunal activity, and belowground processes.

Implementing multiple treatment types, including inexpensive, minimal-input treatments, can be a bet-hedging strategy against treatment failures, enabling restoration projects to produce at least partially favorable outcomes despite failure of some treatments. Integrating minimal-input abiotic treatments in restoration warrants consideration given their low cost and bet-hedging potential.

**Suggestions for further reading:**

*Abella, S.R., and L.P. Chiquoine. 2019. The good with the bad: when ecological restoration facilitates native and non-native species. Restoration Ecology 27:343-351.*

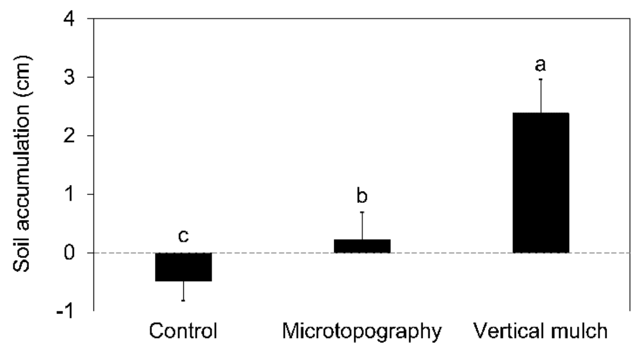


*Fig 3: Cumulative change in soil depth (16 months) among abiotic treatments. Soil accumulated in treated plots while controls continued losing soil.*

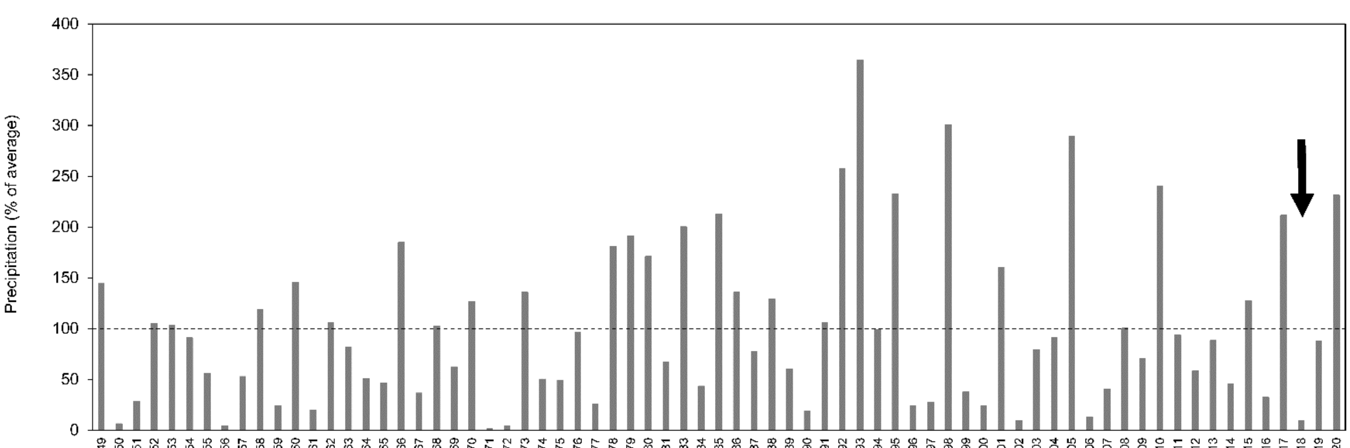


*Fig 2: Winter growing season (November through March) precipitation by year as a percent of the long-term, 1949 through 2020 average of 48 mm in Blythe, CA. The arrow notes implementation of the restoration experiment.*