# A Desert Invader: Stinknet Success Factors

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stinknet.org

## Introduction

Stinknet, *Oncosiphon piluliferum*

Credit: John Scheuring, Sonoran Desert Cooperative Weed Management Area

Stinknet is an annual forb native to South Africa. Since its introduction to California in the 1980s, it has expanded into Arizona and established as an invasive species. This has posed a management problem because stinknet:

- Crowds out and may suppress the growth of native Sonoran Desert annual herbs
- Serves as "ladder fuel" for wildfires when it dries, allowing fire to spread to taller nearby plants.
- Is unpalatable to herbivores, reducing available grazing area for wildlife and livestock

Understanding of what facilitates stinknet invasion in the Sonoran Desert is under-developed, creating a challenge for land managers trying to control its spread. In this study, we ask:

- What soil properties are associated with the spread of stinknet?
- Are there species of native plants capable of outcompeting stinknet during restoration and prevent it from re-establishing?

## Methods

### FIELD SURVEY

- Five 100-meter transects at the study site in Cave Creek Regional Park, with 11 plots each.
- Plant community composition was measured, including stinknet abundance, in a 1m x 1m quadrat at each plot.
- Surface soil (top 10 cm) was collected from the first plot of each transect (as per permit regulations). Soils were returned to the lab and analyzed for soil water content (SWC) and plant-available forms of mineral nutrients ($NO_2$+$NO_3$, $NH_4$, and $PO_4$).



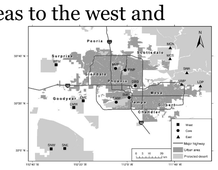
### ARCHIVED DATA

The Central Arizona-Phoenix Long-Term Ecological Research (CAP-LTER) program has been collecting data on annual plant communities in the Phoenix Metropolitan Area for ~25 years. We used archived data from one of the long-term research projects, ongoing since 2009.

### *Desert Fertilization Experiment*

CAP-LTER has been monitoring the impacts of long-term N deposition. More details are available via the QR code to the right, but in brief:

- 15 desert parks across the urban core and exurban areas to the west and east of the city (n=5 per location)
- At each site, a manipulative fertilization experiment tests the impacts of added N (60 kg N $ha^{-1}$ $yr^{-1}$ as solid $NH_4NO_3$), P (12 kg P $ha^{-1}$ $yr^{-1}$ as triple super-phosphate), N+P together, in comparison to a control (C) with no amendments.
- Annually since 2009, the annuals plant community has been assessed in four 1m x 1m quadrats within each fertilization treatment: 2 beneath a perennial shrub (*Larrea tridentata*) and 2 in interplant spaces. Abundance of each species present is recorded as the proportion of the 1m² area.



## Results

### FIELD SURVEY

Soils beneath stinknet plants did not significantly differ in SWC from soil without stinknet. However, stinknet presence was associated with significantly lower nitrate and marginally higher phosphate (Figure 1).

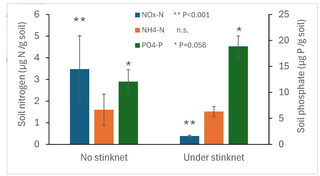



Figure 1. Soil mineral nutrient availability at Cave Creek Regional Park according to stinknet presence.

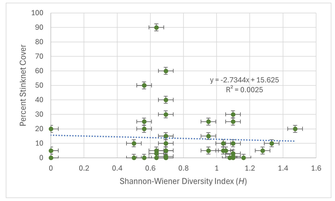



Figure 2. Shannon-Wiener diversity index in comparison to stinknet cover at Cave Creek Regional Park.

Stinknet abundance is not significantly correlated with overall plant community diversity, suggesting limited evidence for competitive exclusion (Figure 2). Similar results were found for evenness.

Further, the field data show that stinknet is equally abundant under shrubs as in intershrub spaces, suggesting that shading is not a deterrent.

### DESERT FERTILIZATION EXPERIMENT

Stinknet abundance has increased in the Phoenix Metropolitan Area since measurements began in 2009 (Figure 3). Within that increase over time, stinknet has spread to greater abundance in desert remnant parks inside the urban core compared outlying exurban desert areas (Figure 4).

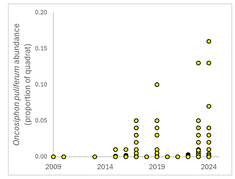



Figure 3. Stinknet abundance across 15 sites in and surrounding Phoenix, AZ over 15 years of measurements.

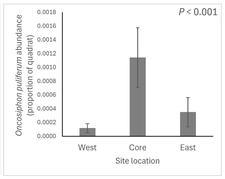



Figure 4. Average stinknet abundance (±SE) across desert sites in the urban core and exurban sites to the west and east (n=5) over 15 years of study.

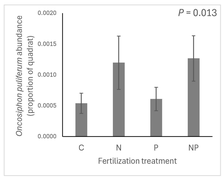



Figure 5 Average stinknet abundance (±SE) in different fertilization treatments across 15 desert sites over 15 years.

Across these locations and time, stinknet abundance was also significantly higher under N and N+P fertilization (Figure 5).

Further, stinknet abundance was higher under shrubs than in interplant spaces ($P$<0.001).

We then focused on correlations between stinknet and the abundance of other annual plant species at these sites, focusing on the past two years during which stinknet abundance was highest: 2023 – 2024. Pearson correlations show that stinknet (*O. piluliferum*) is weakly but positively associated with the presence of numerous species, most strongly with the invasive *B. rubens* (Figure 6). Negative correlations exist with several species, including those in the genera *Pectocarya* and *Schismus*, but they are individually not significant ($P$ > 0.05 for all of them).

Notably though, *Schismus* spp., which is dominated by the invasive *S. arabicus*, is significantly and negatively correlated with numerous species, in particular the native *P. recurvata*. These species do co-occur, but where *Schismus* is abundant, *P. recurvata* is low, and vice versa.

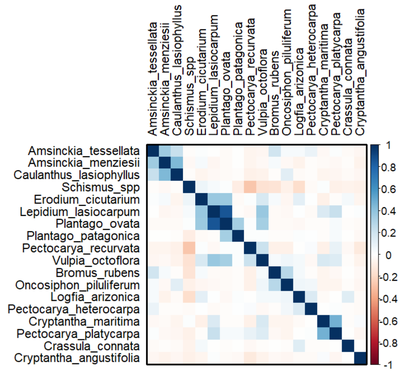



Figure 6 Pearson correlations between abundant annuals species that co-occur with invasive stinknet (*O. piluliferum*)

Species within the genera *Schismus* were not always able to be identified to species in the field. Thus, all specimens were grouped at the genus level for these analyses. When species-level identification was made (in over half the data), and the genus was overwhelmingly dominated by *S. arabicus* compared to *S. barbatus*.

## Discussion

- Stinknet appears to be facilitated by nitrogen availability. Plots receiving N fertilization had an increased abundance of stinknet. Abundance was also higher inside the urban core, where ambient N deposition is ~20% higher (7.2 kg $ha^{-1}$ $yr^{-1}$) than outside of the city.
- This facilitation by nitrogen appears to reflect heavy N utilization, as stinknet presence significantly decreased mineral N (in particular, the oxidized forms of $NO_2$+$NO_3$) in the soil beneath it. A high N demand is characteristic of plants with rapid photosynthesis rates, as it is needed to generate photosynthetic enzymes. Because N is significantly reduced by stinknet presence, stinknet invasion may alter Sonoran Desert N cycling.
- Stinknet appears to be facilitated by the same factors that facilitate *Bromus* invasions, as they are positively correlated with each other. Shrub species may also facilitate stinknet invasion, despite evidence of light limitation from California.
- While there are negative correlations between stinknet and the presence of other species, these are not significant, suggesting that the lack of stinknet at certain sites is not the result of competitive exclusion. This is further supported by the field data, which shows no significant change in plant community diversity in the presence of stinknet.

## Next steps

- The Desert Fertilization Experiment provides a rich level of plant community data, yet the analyses presented here are only preliminary correlations. Further analyses will focus on more detailed community analyses with and without stinknet, such as for altered diversity and evenness or shifts in community composition. This will allow us to identify patterns over a greater range of sites than just our one field site at Cave Creek Regional Park.
- CAP-LTER collects long-term plant community data in other projects, including the Ecological Survey of Central Arizona, which has collected plant data at 200 sites across land uses in the Phoenix Metropolitan Area every 5 years since 2000. Analyses on this dataset are just beginning, but will allow us to investigate the role of land use, land use history, and a suite of associated soil physicochemical properties in stinknet presence or absence.
- The most recent spring season has demonstrated the importance of precipitation on stinknet success, and this environmental parameter will be added to the models.

## Acknowledgements

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