Restoring Mojave Desert Ecosystems: Status of Knowledge and Future Directions

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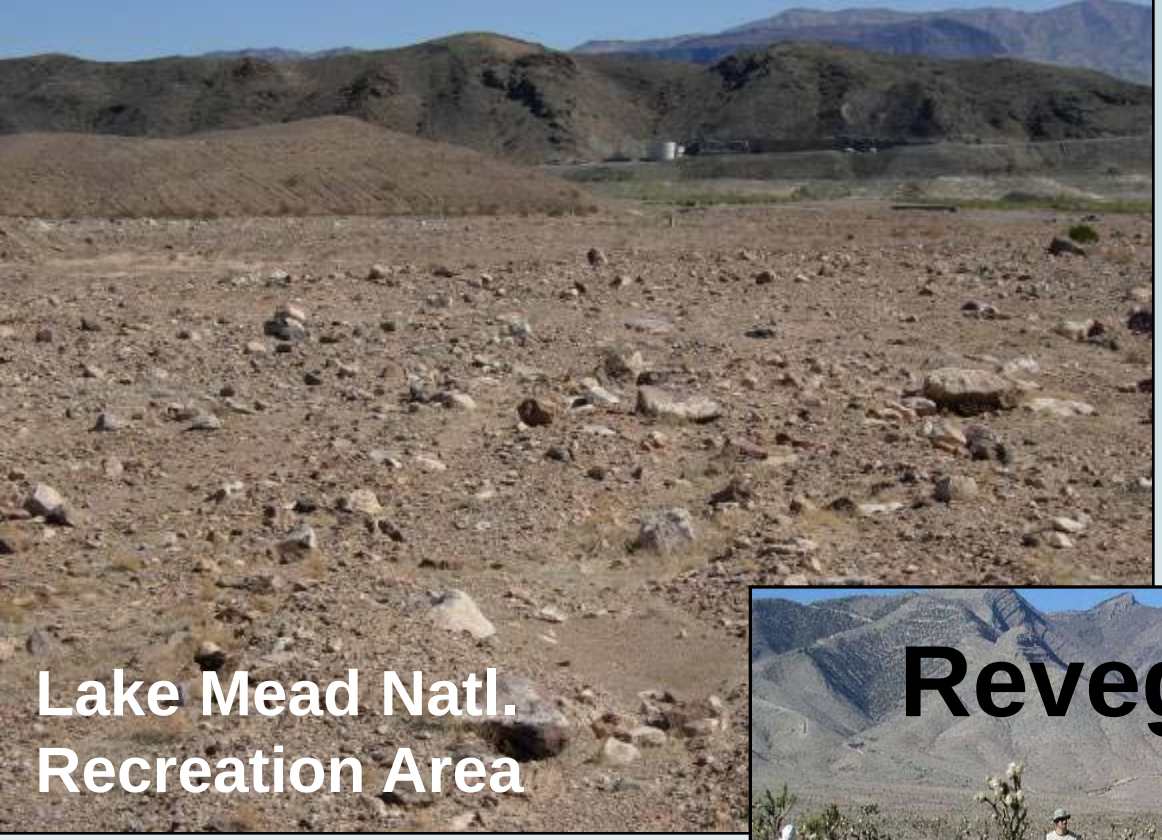
Outplanting on a s. NV burn

08/17/2011

Many disturbance types



Lake Mead Natl. Recreation Area

Reveg is expensive

Wildfire, SE of Vegas, BLM

Goal and Outline

To illustrate some key principles of desert restoration and future advances

- **Natural recovery**
- **Revegetation tmts**
- **Constraining exotics**
- **Future advances**

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Review

Disturbance and Plant Succession in the Mojave and Sonoran Deserts of the American Southwest

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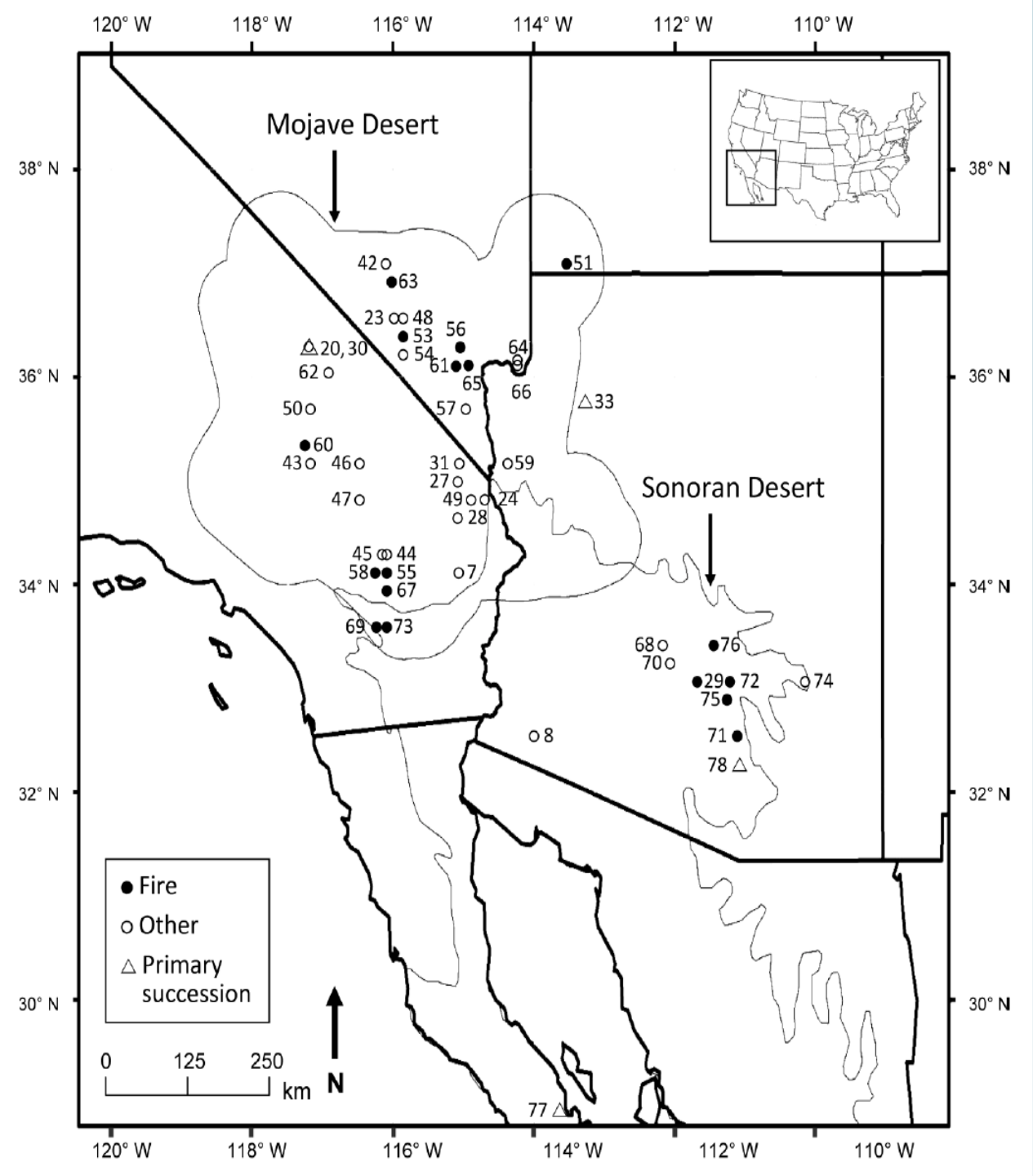
Abstract: Disturbances such as fire, land clearing, and road building remove vegetation and can have major influences on public health through effects on air quality, aesthetics, recreational opportunities, natural resource availability, and economics. Plant recovery and succession following disturbance are poorly understood in arid lands relative to more temperate regions. This study quantitatively reviewed vegetation reestablishment following a variety of disturbances in the Mojave and Sonoran Deserts of southwestern North America. A total of 47 studies met inclusion criteria for the review. The time estimated by 29 individual studies for full reestablishment of total perennial plant cover was 76 years. Although long, this time was shorter than an estimated 215 years (among 31 individual studies) required for the recovery of species composition typical of undisturbed areas, assuming that recovery remains linear following the longest time since disturbance measurement made by the studies.

Keywords: arid land; recovery; revegetation; fire; management; resource damage; dust mitigation; diversity

Recovery from disturbance

Tramp Fire,
Gold Butte, NV



47 studies

Years to recovery

Cover: 76

Richness: 38

Composition: 215

Annuals: shorter

Pipeline water intake area of Las Vegas, W of Lake Mead. Age 38 yrs

Meeting functional objectives, and by-product benefits

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677 South Segoe Rd., Madison, WI 53711 USA

Seeding Native Plants to Restore Desert Farmland and Mitigate Fugitive Dust and PM_{10}

David A. Grantz,* David L. Vaughn, Rob Farber, Bong Kim, Mel Zeldin, Tony VanCuren, and Rich Campbell

ABSTRACT

Windblown fugitive dust contributes to violations of air quality standards for particulate matter <10 μm aerodynamic diameter (PM_{10}). In the western Mojave Desert of California, approximately 1070 ha of previously tilled or over-grazed land impacted downwind metropolitan areas by wind-driven emissions of dust. A protocol of furrowing across the wind and direct seeding of three native perennial shrubs and a bunch grass helped reduce fugitive dust emissions in this area by more than 95%. Seeded species varied from 35 to 97% of living plant cover in individual years, reflecting rainfall patterns. In areas of deep sand, Indian ricegrass (*Achnatherum hymenoides* Roemer & Shultes) outperformed the shrubs, while fourwing saltbush [*Atriplex canescens* (Pursh) Nutt.] exhibited the most widespread establishment. This revegetation was achieved in an anomalous year with above average and late rainfall that eliminated early competition from annual species and later fostered abundant shrub growth. This success was not reproducible in more normal years, when minimal disturbance protocols such as broadcasting of seed on the untilled soil surface were as effective and less costly. We conclude: (i) direct

TABLE 2. Control of fugitive dust at 3.3 feet above the ground by directly seeded vegetation in the Emergency Watershed Protection Program for periods with wind gusts above 34 mph

Dust collected		Control
Barren area	EWP area	
g		%
75.1*	0.380	99.5
0.47†	0.013	91.0

*Drought conditions, 1992. Control area in western Antelope Valley.
†Wet conditions, 1994–1996 average. Control area in mid-Antelope Valley.

A Systematic Review of Species Performance and Treatment Effectiveness for Revegetation in the Mojave Desert, USA

Scott R. Abella[*1] *and Alice C. Newton*[2]

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[2] National Park Service, Lake Mead National Recreation Area, 601 Nevada Way, Boulder City, NV 89005, U.S.A.

Abstract

Land managers need ecologically and cost-effective strategies for revegetating arid lands, such as the Mojave Desert in the southwestern United States. Many disturbances – failed agricultural attempts, grazing by exotic herbivores (e.g., burros, cattle), creating roads, land clearing for military or mining activities, off-road vehicle use, and wildfires fueled by exotic grasses – have modified or eradicated native vegetation. Natural revegetation often is slow, or consists of exotic species that do not meet management objectives. As a result, active revegetation using native species may be required to accomplish ecological and utilitarian objectives, such as enhancing native plant communities, curtailing fugitive dust that poses a human health hazard, or establishing non-flammable vegetation for reducing wildfires. We evaluated the following questions by systematically reviewing published revegetation studies in the Mojave Desert: (1) Which species have been most commonly and effectively planted or seeded? (2) Which treatments have increased plant establishment? (3) What are the relative performances of planting and seeding, and are these species specific? Fifteen planting studies assessed a total of 41 species, 33 of them shrubs. None of the nine species planted in ≥ 3 studies avoided a complete failure (0% survival) in one or more treatments in one or more studies, but several species (e.g., *Larrea tridentata*, *Atriplex* spp.) consistently exhibited high (> 50%) survival. Fencing, shelters, and irrigation increased survival of some species, but these treatments require cost/benefit analyses. Though seeding frequently has been discouraged relative to planting, seeding success is species and situational specific.

2009

Literature Review:

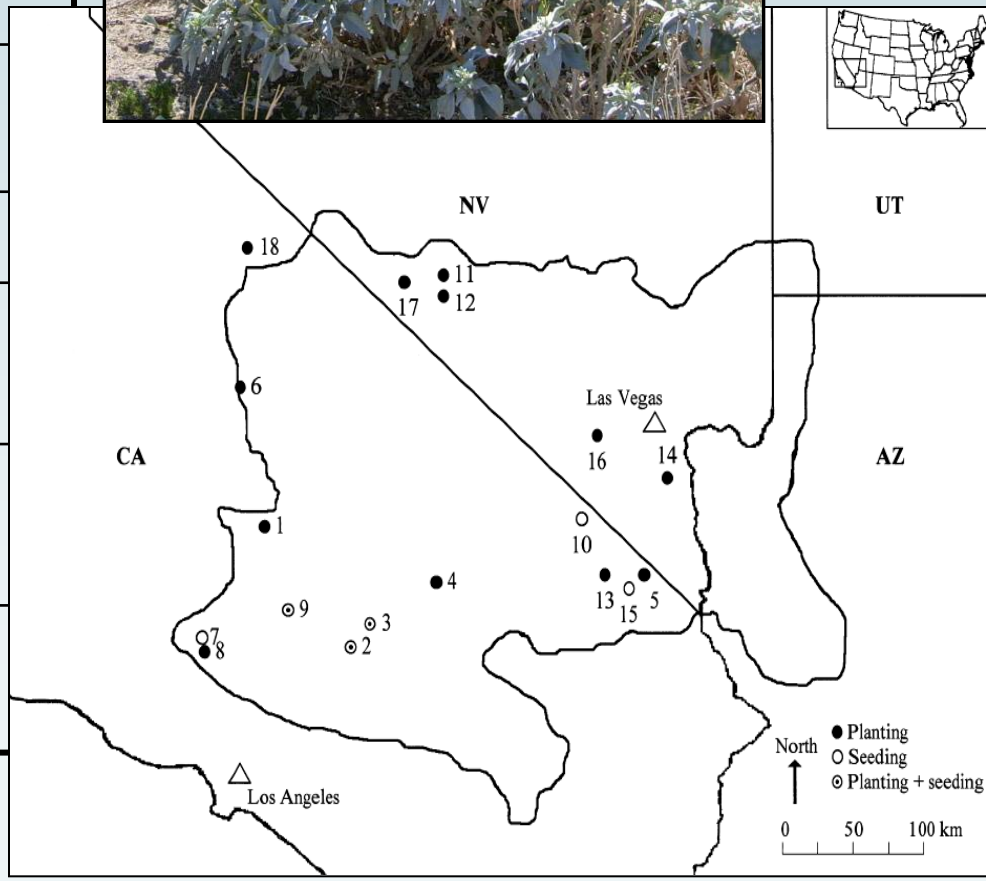
Planting/seeding research in the Mojave

UNLV-NPS partnership

Results: Summary of Studies

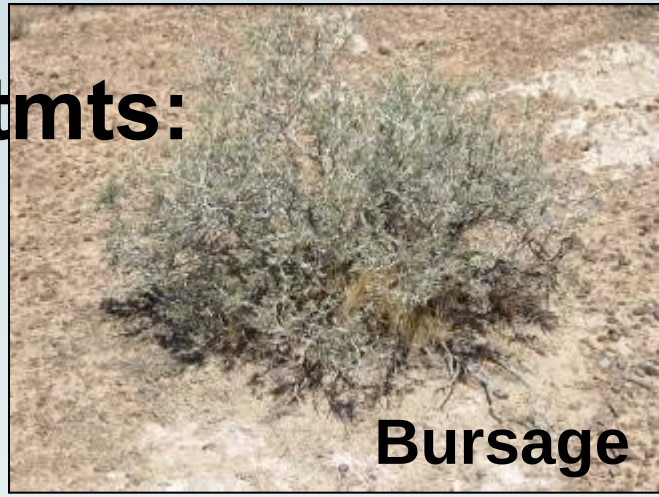
	Planting	Seeding
No. studies	13	8
Environments, e.g.	Corridors, mine spoil	Old road, ag land
Precipitation (%)	27-148	33-157
No. spp/study	1-21	3-12
Care, e.g.	Irrigation, cages	Less common
Tmts tested, e.g.	Shelters, cages	Less common
Years monitored	1-5	1-5

Brittle-bush



Planting – species comparisons

- 40 total species, 36 of them shrubs
- 16 species planted in ≥ 2 studies
- ≥ 50% survival in 1 or more tmts:
  - White bursage 5/9 studies
  - Creosote 5/7 studies
  - Fourwing saltbush 4/5, alkali saltbush 2/3
  - Nevada jointfir (*Ephedra*), cheesebush (*Hymenoclea*), Mojave yucca 2/2


Bursage

Seeding – Species Comparisons

- **26 total species**
  - **White bursage est. in 3/3 studies (e.g. 0.1/m^2)**
  - **Saltbush spp. 3/3 (e.g., 0.6-4.2/m^2)**
  - **In a study of 12 spp: Palmer's penstemon 7 plants/m^2, desert marigold 3 plants/m^2**
  - **Creosote fails in 2/3 studies**

Saltbush

Marigold

Thoughts

- **Species specificity**
- **Species that establish infrequently in nature (e.g., late successional creosote), establish better by planting than by seeding w/o supplemental tmt**
- **Species that need little tmt for establishing are a key for reveg**
- **Multifactor studies essential**
- **Publication bias**
- **Reveg can meet mgt. objectives in certain contexts**

- **Saguaro, Joshua Tree NP, Mojave, L.A. DeFalco**

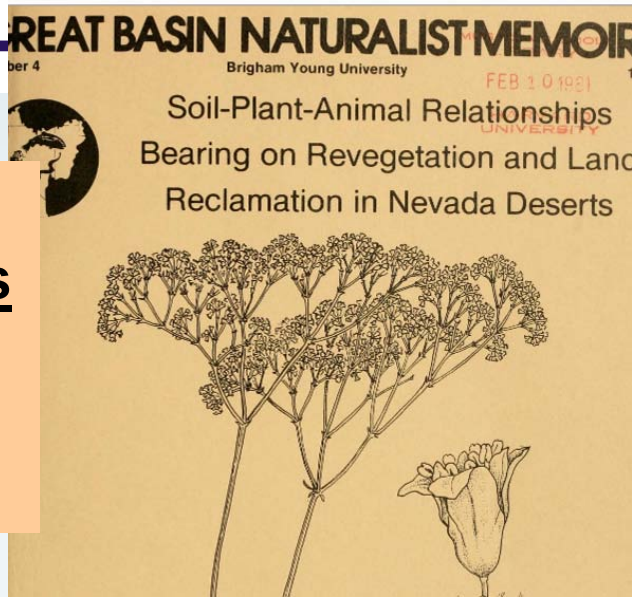
Restoring structure

The role of nurse plants in the restoration of degraded environments

Francisco M Padilla* and Francisco I Pugnaire

Traditional ecological models have focused mainly on competition between plants, but recent research has shown that some plants benefit from closely associated neighbors, a phenomenon known as facilitation. There is increasing experimental evidence suggesting that facilitation has a place in mainstream ecological theory, but it also has a practical side when applied to the restoration of degraded environments, particularly drylands, alpine, or other limiting habitats. Where restoration fails because of harsh environmental conditions or intense herbivory, species that minimize these effects could be used to improve performance in nearby target species. Although there are few examples of the application of this "nursing" procedure worldwide, experimental data are promising, and show enhanced plant survival and growth in areas close to nurse plants. We discuss the potential for including nurse plants in restoration management procedures to improve the success rate of such projects.

Front Ecol Environ 2006; 4(4): 196–202



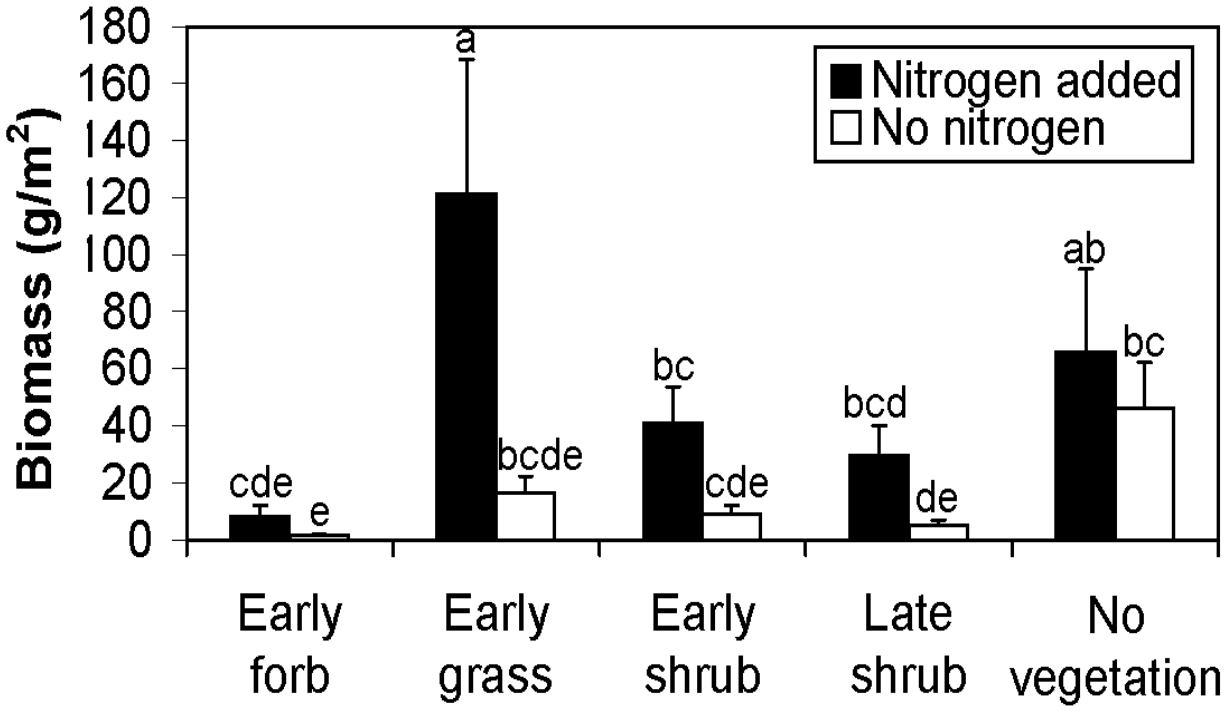
Romney et al. (1980) The challenge of a desert: revegetation of disturbed desert lands

- **Stressed soil fertility, fertile islands**
- **But is this good???**

Constraining exotic species

- **Invasion-reducing communities**
- **Five community types: early forb, early shrub, grass, late shrub, none**
- **Each of 12 species also grown individually**
- ***Bromus* or *Schismus* added, nitrogen added or not**

Invasibility Community Experiment: Results



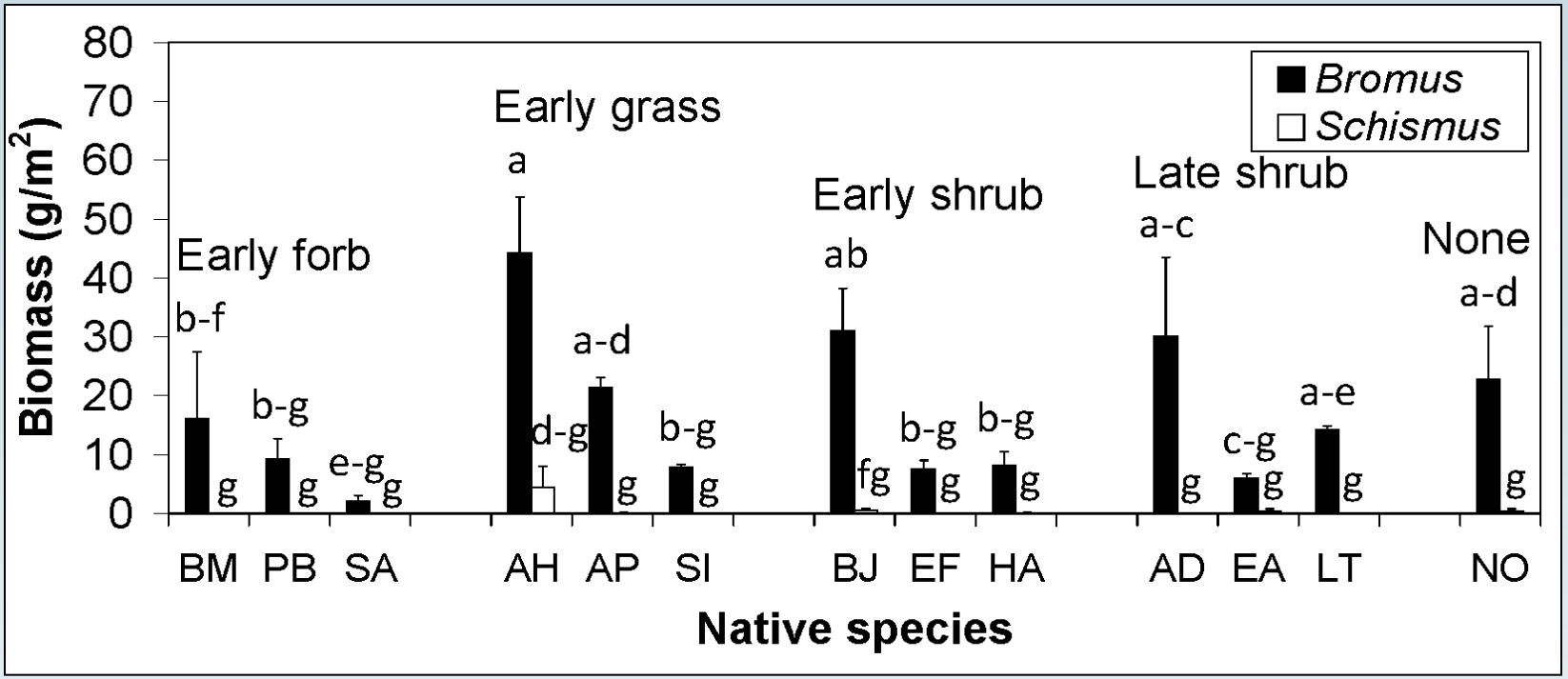
Early forb:
Baileya multiradiata
Penstemon bicolor
Sphaeralcea ambigua

Early grass:
Achnatherum hymenoides
Aristida purpurea
Sporobolus airoides

Early shrub:
Bebbia juncea
Encelia farinosa
Hymenoclea salsola

Late shrub:
Ambrosia dumosa**
Eriogonum fasciculatum
Larrea tridentata

Invasibility Species Experiment: Results



***Sphaeralcea ambigua* (SA – desert globemallow): 11-fold reduction**

Cover of natives not sig. related to exotic biomass

Globemallow

Invasive Plant Science and Management 2011 4:115–124

Relationships of Native Desert Plants with Red Brome (*Bromus rubens*): Toward Identifying Invasion-Reducing Species

Scott R. Abella, Donovan J. Craig, Lindsay P. Chiquoine, Kathryn A. Prengaman, Sarah M. Schmid, and Teague M. Embrey*

The interactions between native and exotic species occur on a continuum from facilitative to competitive. A growing thrust in invasive species science is differentiating where particular native species occur along this continuum, with practical implications for identifying species that might reduce the invasibility of ecosystems. We used a greenhouse experiment to develop a competitive hierarchy of 27 native species with red brome, an invasive annual grass in the arid lands of the southwestern United States, and a field study to assess in situ responses of brome to native perennial species in the Mojave Desert. Native species most competitive with brome in the competition experiment included the annuals Esteve's pincushion and western fiddleneck and the perennials eastern Mojave buckwheat, sweetbush, and brittlebush, which reduced brome biomass to 49 to 70% of its grown-alone amount. There was no clear difference in competitive abilities with brome between annual and perennial natives, and competiveness was not strongly correlated ($r = 0.15$) with the biomass of the native species. In the field, sweetbush and brittlebush supported among the least cover of brome, suggesting congruence of the strong early competitive abilities of these species with in situ patterns of brome distribution. At the other extreme, brome attained its highest average cover (19%) below littleleaf ratany, significantly greater than all but 3 of the 16 species evaluated. Cover by brome was only weakly related ($r = 0.19$) to the area of the perennial canopy, suggesting that factors other than the sizes of perennial plants were linked to differences in brome cover among species. Results suggest that (1) interactions with brome differ substantially among native species, (2) these interactions are not as closely linked to biomass production as in more temperate regions, and (3) there is potential for identifying native species that can reduce invasion of desert ecosystems.

Correlation Study: Methods & Results

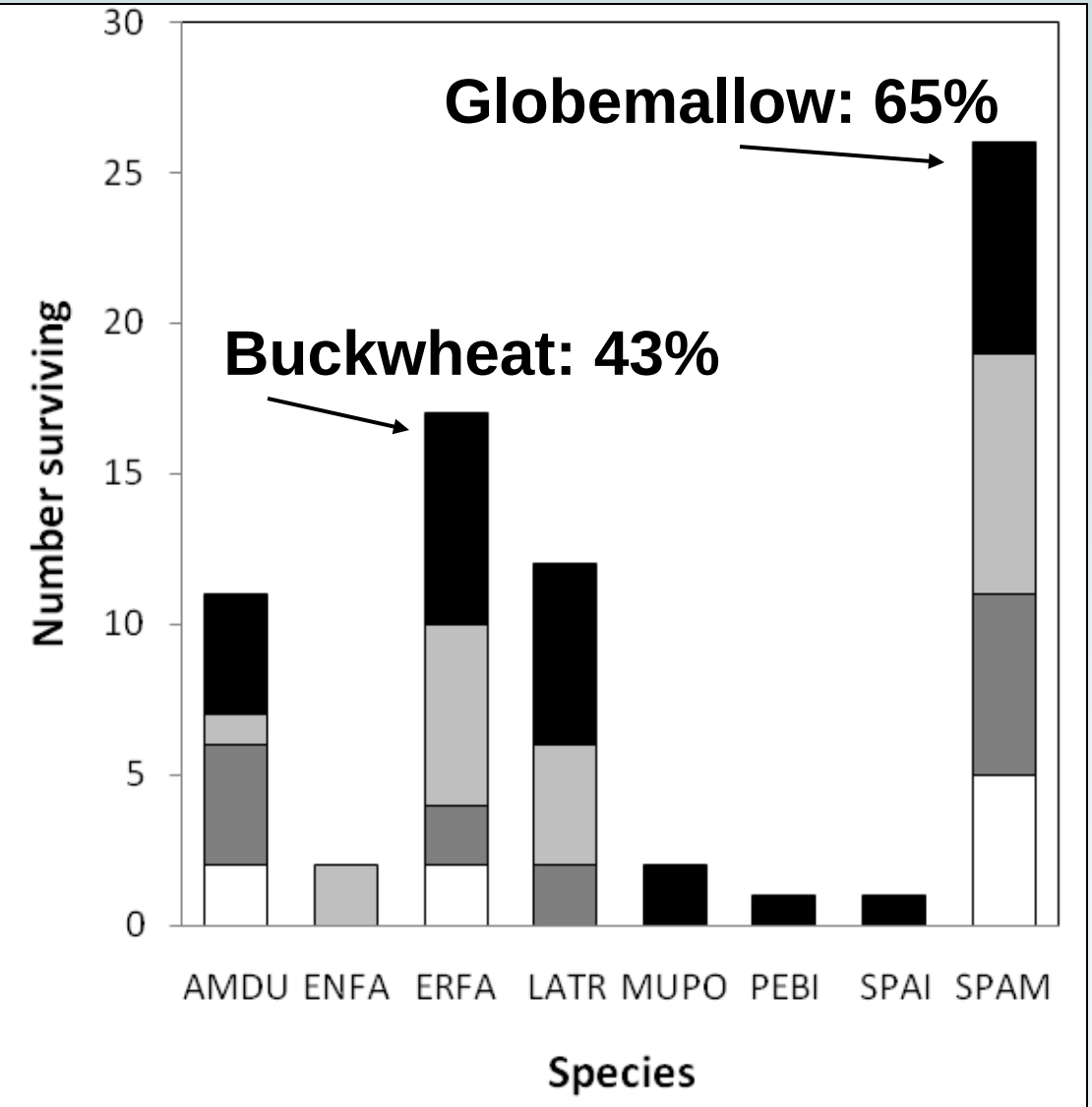
- **7 sites, *in situ* patterns**
- **Categorize *Bromus* cover below perennials**

Microsite	Median	95% CI[a]	n[b]
Interspace	1 a	1-2	56
Thamnosma montana	2 ab	2-5	22
Bebbia juncea	2 abc	0-9	7
Encelia virginensis	2 abc	1-19	7
Salazaria mexicana	2 abc	2-9	9
Encelia farinosa	3 bc	2-5	30
Coleogyne ramosissima	5 abc	2-5	40
Pleuraphis rigida	5 abcd	2-9	6
Menodora spinescens	5 bc	5-5	37
Psorothamnus fremontii	5 bc	2-9	29
Ambrosia dumosa	5 c	5-9	22
Eriogonum fasciculatum	5 bc	2-38	11
Gutierrezia sarothrae	5 bc	2-9	11
Hymenoclea salsola	9 bcd	2-38	10
Larrea tridentata	9 bcd	2-38	13
Ephedra torreyana	9 c	5-19	28
Krameria erecta	19 d	19-19	37

- ***Bromus* cover varied 19-fold among interspaces and native perennial plant microsites**

Reality Check: Results

- **Planting effective, seeding not**



Globemallow

Implications of Findings

- **Planting works; Seeding uncertain; Cost-benefit.**
- **Species selection; Specificity; Propagule increase.**
- **Soil ER – successful one level, infancy other.**
- **Attention to function and objectives, succession.**

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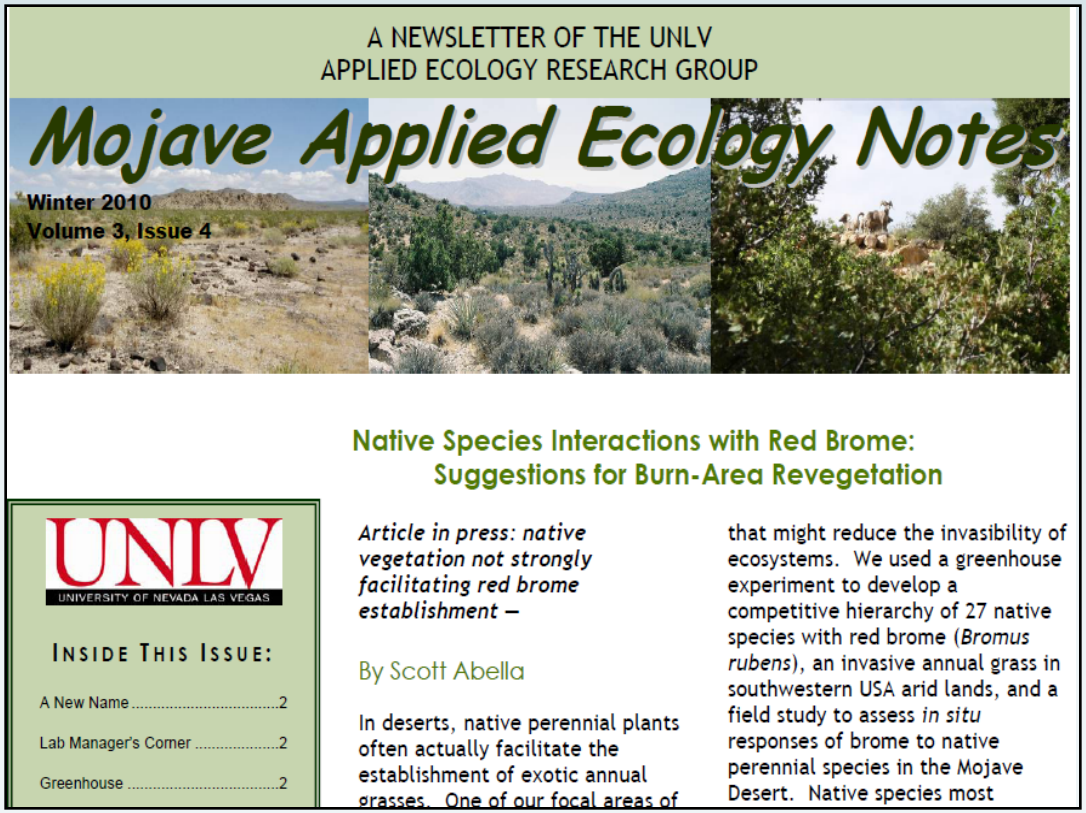

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Mojave Applied Ecology Notes

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Native Species Interactions with Red Brome:
Suggestions for Burn-Area Revegetation

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Article in press: native vegetation not strongly facilitating red brome establishment –

By Scott Abella

In deserts, native perennial plants often actually facilitate the establishment of exotic annual grasses. One of our focal areas of

that might reduce the invasibility of ecosystems. We used a greenhouse experiment to develop a competitive hierarchy of 27 native species with red brome (*Bromus rubens*), an invasive annual grass in southwestern USA arid lands, and a field study to assess *in situ* responses of brome to native perennial species in the Mojave Desert. Native species most

“The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.” It is an intentional activity that initiates or accelerates the recovery of an ecosystem.

The SER International Primer on Ecological Restoration

Society for Ecological Restoration International
Science & Policy Working Group (Version 2: October, 2004)*