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POST-FIRE PLANT RECOVERY IN THE MOJAVE AND SONORAN DESERTS OF WESTERN NORTH AMERICA

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Table 1. Summary of studies meeting inclusion criteria that examined post-fire plant recovery in the Mojave and Sonoran Deserts.

	Data type	
Reference	**Resprout**	**Community**
Mojave Desert		
Abella et al. unpubl.	×	×
Brooks and Matchett 2003		×
Callison et al. 1985		×
Lei 1999		×
Medica et al. 1994		×
Minnich 1995	×	×
Webb et al. 2003		×
Sonoran Desert		
Abella et al. 2009		×
Brown and Minnich 1986	×	×
Cave and Patten 1984		×
McLaughlin and Bowers 1982	×	×
O'Leary and Minnich 1981		×
Rogers and Steele 1980	×	
Wilson et al. 1995		×

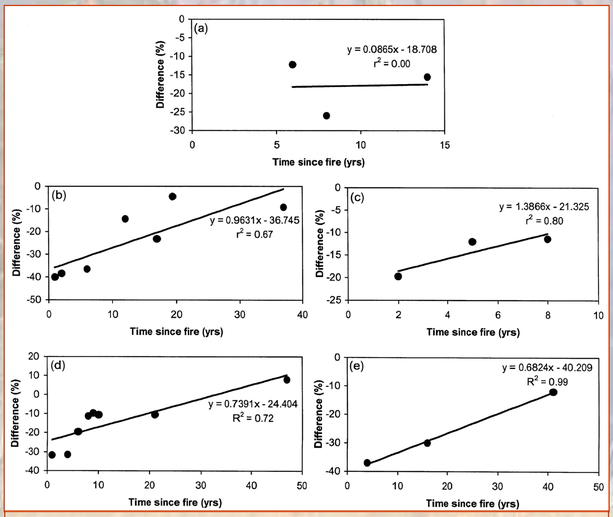

Fig. 1. Relationship of time since fire and total perennial plant cover for five studies using either chronosequence (a, b, and d) or permanent plot (c and e) approaches. Y-axes are burned minus unburned cover to provide a measure of recovery standardized for unburned cover where values of zero represent equal burned and unburned cover. (a) = Brooks and Matchett 2003, (b) = Callison et al. 1985, (c) = Medica et al. 1994, (d) = Minnich 1995, and (e) = Webb et al. 2003.

REFERENCES

Full citations are not provided due to space but are available by contacting the author.

PROJECT RATIONALE

Fire is thought to have been generally rare historically in the Mojave and Sonoran Deserts. However, invasion by exotic grasses (e.g., *Schismus* spp.) has increased fuel continuity, promoting fire in these deserts. Succession and recovery are not well understood processes in deserts, nonetheless for a novel disturbance like fire. In addition to helping build theories of desert succession and recovery, information on post-fire recovery has numerous practical implications (e.g., determining whether active revegetation is needed).

Systematic reviews provide a means for obtaining literature using reproducible search criteria. This approach facilitates a balanced appraisal of available information, synthesizes scattered literature, and may result in insights not apparent by examining research studies individually. Using the systematic approach, I addressed these questions:

(1) What are post-fire resprouting frequencies among species?
(2) How quickly does perennial plant cover recover following fire?
(3) What is the relationship of species composition and time since fire?
(4) Which species are major post-fire colonizers?
(5) What variation occurs in post-fire responses between deserts?

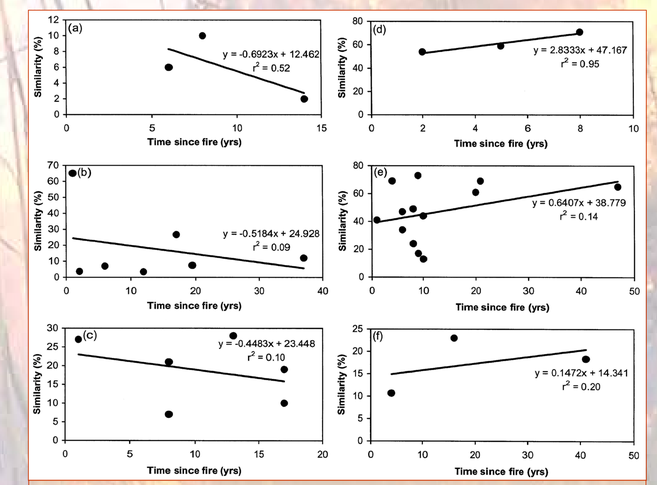

Fig. 2. Relationship of time since fire and the Sørensen similarity of burned and unburned perennial species composition for six studies. Sørensen similarities range from 0-100%, with 100% being identical species compositions. (a) = Brooks and Matchett 2003, (b) = Callison et al. 1985, (c) = Lei 1999, (d) = Medica et al. 1994, (e) = Minnich 1995, and (f) = Webb et al. 2003.

Table 2. Resprouting percentages of representative species (of 31 species) after fire.

	Reference[1]				
Species	**1**	**2**	**3**	**4**	**5**
Acacia greggii					**75**
Ambrosia deltoidea			**1**		**1**
Ambrosia dumosa		**8**			
Calliandra eriophylla					**68**
Carnegiea gigantea			**0**		**0**
Cylindropuntia bigelovii		**6**			**2**
Encelia farinosa		**5**			**0**
Hyptis emoryi		**40**			
Larrea tridentata	**5**	**3**	**37**	**18**	**7**
Yucca brevifolia				**17**	
Yucca schidigera	**64**			**86**	

[1] 1 = Abella et al. unpubl., 2 = Brown and Minnich 1986, 3 = McLaughlin and Bowers 1982, 4 = Minnich 1995, and 5 = Rogers and Steele 1980.

METHODS

♦ Searched the article databases of Google Scholar, Agricola, Biological Abstracts, and JSTOR using combinations of the key words "succession," "disturbance," "fire," "recovery," "change," "Mojave," and "Sonoran."
♦ Searched other reviews (e.g., Fire Effects Information System) and reference lists in located papers, and cross-reference search.
♦ To qualify for inclusion in the review, studies had to monitor vegetation after wildfire or prescribed fire in the Mojave or Sonoran Deserts, report quantitative resprout or community data, include unburned areas for comparison, and be published.
♦ To analyze community data, I updated species nomenclature and computed a relative measure of abundance to standardize the different raw measures (cover, density, or frequency) reported in original publications.

HIGHLIGHTS

♦ A total of 14 studies met inclusion criteria, with seven studies conducted in each of the Mojave and Sonoran Deserts (Table 1).
♦ Five studies measured post-fire resprouting of native perennials, providing resprout frequency estimates for 31 species (Table 2). Resprouting was generally limited but varied among species.
♦ Three studies covering the longest time since fire (>30 years) found that total perennial cover had recovered to within 10% (raw cover) of unburned cover within approximately 40 years (Fig. 1).
♦ In contrast to cover, burned perennial species composition showed little trend to converge with unburned composition overall among six studies ranging from 1-47 years since fire (Fig. 2).
♦ Based on ordinating data from 13 community studies, overall perennial composition after fire differs between the Mojave and Sonoran Deserts (Fig. 3).
♦ Some species exhibited versatility by being dominants in both burned and unburned habitat (e.g., *Ambrosia deltoidea*, *Ephedra nevadensis*), at least in terms of their relative abundance even if their raw abundance declined after fire.1

CONCLUSION

This analysis suggests that post-fire composition consists both of resprouting species present prior to the fire and early colonizers that are more, less, or similar in abundance to unburned areas. It is unclear how much time is required for species composition on burns to resemble that of unburned areas, as generally weak trends for compositional convergence were evident even in the longest studies exceeding 37 years since fire. It also is possible that even in the absence of further fire, fire has induced a new trajectory of vegetation change diverging from unburned areas. However, though species compositions will differ, it appears that total perennial cover on burns will resemble that of unburned areas within approximately 40 years after fire. This analysis highlights a need for additional original studies to generate data in which to search for patterns in post-fire recovery.

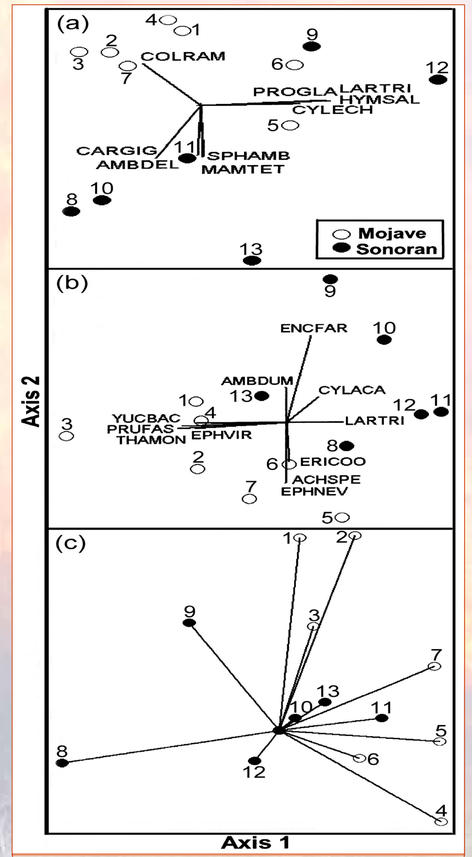

Fig. 3. Non-metric multidimensional scaling ordination of (a) unburned, (b) burned, and (c) standardized burned perennial species composition for 13 studies measuring post-fire plant recovery in the Mojave and Sonoran Deserts. In (a) and (b), species are vectors where vector lengths and directions are proportional to correlations with ordination axes (r^2 cutoff = 0.40 for (a) and 0.25 for (b)). In (c), burned composition was standardized with unburned composition as a covariate where vector lengths depict the relative deviance of burned from unburned composition. Species abbreviations for (a) and (b): ACHSPE = *Achnatherum speciosum*, AMBDEL = *Ambrosia deltoidea*, AMBDUM = *Ambrosia dumosa*, CARGIG = *Carnegiea gigantea*, COLRAM = *Coleogyne ramosissima*, CYLACA = *Cylindropuntia acanthocarpa*, CYLECH = *Cylindropuntia echinocarpa*, ENCFAR = *Encelia farinosa*, EPHNEV = *Ephedra nevadensis*, EPHVIR = *Ephedra viridis*, ERICOO = *Ericameria cooperi*, HYMSAL = *Hymenoclea salsola*, LARTRI = *Larrea tridentata*, PROGLA = *Prosopis glandulosa*, PRUFAS = *Prunus fasciculata*, SPHAMB = *Sphaeralcea ambigua*, and THAMON = *Thamnosma montana*.

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