

EFFECTS OF FIRE ON SALT-DESERT SHRUB RANGELANDS

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ABSTRACT

*Fire was not thought to be a driving variable in salt-desert shrub ecosystems prior to 1983. The El Niño related extreme wetness of 1983-85 resulted in a profusion of mostly exotic annuals followed by wildfires. Unfortunately, the most productive sites, near the upper boundary of the type, have been most often affected. Major species such as shadscale (*Atriplex confertifolia*) and budsage (*Artemisia spinescens*) do not resprout following fire. Winterfat (*Ceratoides lanata*), saltbush (*Atriplex nuttallii*), gray molly (*Kochia americana*) and black greasewood (*Sarcobatus vermiculatus*) do resprout, but subsequent populations appear reduced.*

INTRODUCTION

Just a decade ago I would have not ever dreamed of addressing this topic. In fact, in my (West 1983) review of salt-desert shrub ecosystems, I explicitly said that fire was not part of that environment. Blaisdell and Holmgren (1984) also fail to mention fire in their more management-oriented review. There was no literature or experience at the time of writing for us to say otherwise. In another review (West 1988) only 5 years later, I had to recant that view.

The difference is due to the extremely wet conditions of 1983-85, the profusion of mostly exotic annuals, and subsequently, wildfires. Before we discuss the consequences of those events in the 1980's, let us define the environment and biota of the ecosystems under consideration here.

FEATURES OF THE SALT-DESERT SHRUB ECOSYSTEM TYPE

The term "salt-desert shrub" tells three important aspects of its character—that it is climatically dry, the soils are usually salty, and the vegetation is dominated by shrubs. Such circumstances are found over about 17×10^6 ha of lowlands in all four regional deserts of North America, plus parts of the Great Plains and the San Joaquin Valley of California (West 1983). The dominant perennial plants are either shrubs or half-shrubs within the Chenopodiaceae.

There are usually three kinds of salt-desert sites occurring in a catena from valley bottom to pediment slope. The valley bottoms are either largely barren salt pans

or wet meadows to marshes, depending on drainage. The wet meadows and marshes usually have free water extending at the surface, for at least half of the year. Thus, these segments of the gradient do not usually support fire. The next higher segment has high water tables, but water does not usually stand on the soil surface. Here the hydrohalophytes dominate. The major shrub there is black greasewood (*Sarcobatus vermiculatus*). The major original grass was Great Basin wildrye (*Elymus cinereus*). Alkali saccaton (*Sporobolus airoides*) has survived unrestricted grazing much better, however.

The most extensive portion of the salt-desert shrub type occurs on the well-drained uplands. The xerohalophytes that occur there are more diverse, including species in saltbushes (*Atriplex*), *Kochia*, winterfats (*Ceratoides*), hopsages (*Grayia*), rabbitbrushes (*Chrysothamnus*), and horsebrushes (*Tetradymia*). Variations in community composition and productivity are intimately related to soil salinity and texture. Total plant cover and production is least on marine shales and greatest on slightly gravelly sites due to the inverse texture principle (Noy-Meir 1973). The latter kind of sites are usually where enough continuous fine fuel can be produced during exceptionally wet years to carry subsequent fires.

LIVESTOCK GRAZING-FIRE-CLIMATE INTERACTIONS

It is now becoming more apparent that livestock grazing has not had an exclusive role in allowing the expansion of introduced annuals, especially cheatgrass (*Bromus tectorum*). While livestock trampling of microphytic soil crusts is sometimes invoked as a cause (West 1990), annuals can be found on relicts without livestock grazing (Svejcar and Tausch 1991). Whisenant and Wagstaff (1991) have shown that even the moderately grazed Desert Experimental Range has shown increased cheatgrass. Heavy spring-use paddocks had a comparatively greater increase in cheatgrass than other combinations of intensity and timing of sheep grazing. While the general truncation of season of use and reduced numbers of livestock on salt-desert ranges can be followed by enhanced abundances of native perennials on some of the Bureau of Land Management's (BLM) salt-desert ranges (Yorks and others 1992), cheatgrass will still remain and even increase. Without livestock consumption of some of these fuels, susceptibility of these lands to fire could increase further.

The shrub "dieback" phenomenon centered on 1983-84 (Nelson and others 1989; Price and others 1992) freed up space and resources that could be utilized by annuals.

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With the annuals came finer and more continuously arrayed fuels that dried up sooner than the original shrubland. Although the shrubs are recovering in some of these areas (Ewing and Dobrowolski 1992), fire may intervene and return them to annual dominance. Wind and water erosion could remove and dilute the soil organic matter and attendant nutrient concentrations around the shrubs (Charley and West 1975), and the consequent safe sites for seedling survival they provide (West 1982; West and Goodall 1986). After fire has eliminated the native perennials, essential mycorrhizae may be extirpated (Wicklow-Howard, these proceedings).

EVIDENCE OF FIRE IMPACT

The above reasons are from the sparse available literature on the topic. Are there concrete examples to demonstrate these patterns? I have come across four circumstances that illustrate the role of fire in effecting change on salt-desert rangeland.

The uppermost segment of the salt-desert shrub type in Curlew Valley, northwestern Utah, has been studied by our department since the 1950's. Gates and others (1956) described the vegetation and soil thoroughly. Cook (1971) described the changes on species populations, regrowth, and carbohydrate reserves following utilization. Rice and Westoby (1978) described the lack of successional recovery in the vegetation of the exclosures established in the early 1950's. Duba (1976) described the population biology of some of the introduced annuals. These studies predating the particularly wet period of 1983-84 allow us to appreciate the extent of change since.

By happenstance, Kevin Connors, a technician in the Forage and Range Laboratory of the USDA Agricultural Research Service, was in Curlew Valley on July 7, 1983, perhaps the most ecologically important day in the history of Curlew Valley this century. Fortunately, Kevin had a camera and the presence of mind to take some slides at permanently locatable points. Comparing those slides with a recent field examination shows that the major fuels in 1983 were bottlebrush squirreltail (*Sitanion hystrix*) grass in the winterfat stands, but tansy mustard (*Descurainia pinnata*) and pepperweed (*Lepidium perfoliatum*) elsewhere. Cheatgrass was less abundant that year than it had been before or since. Although shadscale (*Atriplex confertifolia*)- and saltsage (*Atriplex gardneri*)-dominated plots were burned as well as the winterfat (*Ceratoides lanata*) plots I do not have preburn slides from them. Drawing on Rice and Westoby's (1978) data taken last in 1973 for all three types, we observed that only winterfat and saltsage resprouted after this fire. The shadscale plot had the most cheatgrass of the three and has been altered the most.

The Dugway Proving Ground is another place where some earlier work on salt-desert vegetation was done (Vest 1962). Vest's map shows that shadscale dominated the southwestern corner of that property. Recent monitoring efforts have taken us back to that area. Security reasons prevent me from being able to present photographic evidence, so you will have to take my word for it that shadscale is gone and introduced annuals dominate even though livestock have not been there since 1948.

The sources of fire are somewhat unique. While lightning ignites most fires elsewhere, the more common sources at Dugway are from military ordinance. This area is adjacent to an artillery training ground. How many times this area has burned since Vest made his map, I do not know. I can tell you, however, that the FIREX operations of 1987 led to extensive fires because they escaped to adjacent BLM areas and resulted in intensive efforts at revegetation (Tom Roberts, personal communication 1989). Sparks and others (1990) noted from repeat observations at section corners that fires had changed upper salt desert areas in nearby Skull Valley, UT, some probably prior to the 1980's. The changes were more pronounced and widespread on the more heavily impacted east than west side of the valley.

A fourth instance of fire in salt-desert shrub communities has been pointed out to me by Jim Young. This took place west of Winnemucca, NV, in 1986. Over 600,000 acres were burned, including some shadscale-dominated areas on the upper bajada of the Sand Dunes Allotment of the T Quarter Circle Ranch (Emmerich and others 1992). Abundant cheatgrass carried the fire there. Very little recovery of shadscale was observed in the spring of 1992.

In contrast to these known instances of major fires over some salt-desert shrub rangeland, we also know that some of the most well-studied salt-desert areas have not burned. For instance, no fires have occurred at the Desert Experimental Range (R. Holmgren, personal communication 1990) or farther south in Pine Valley, UT (Yorks and others 1992). There have also been no fires on the long-term study plots of Sharp and others (1990) in Raft River Valley, ID.

It would be nice to be able to say how much of the salt-desert shrub rangeland has been burned and when. This will require agreement on what constitutes the salt-desert shrub type and a consistent way to record fires. Perhaps this can be solved in the future with remote sensing and procedures associated with synoptic monitoring plans such as EMAP (Hunsaker and Carpenter 1990).

If readers know of further examples of fires in salt-desert shrub communities that have some documentation, I would appreciate knowing about them. We can use them as natural experiments to build up our understanding of how this relatively new kind of disturbance influences such vegetation, soils, and wildlife habitat.

RESPONSES OF MAJOR SALT-DESERT PLANT SPECIES TO FIRE

The best that we can presently do to summarize what we know about fire in salt-desert shrub ecosystems is to note the response of major plant species to fire (table 1). This information was assembled from the Fire Effects Information System (Fischer and Wright 1987), Intermountain Fire Sciences Laboratory, Intermountain Research Station, USDA Forest Service, Missoula, MT, personal experience, and volunteered comments obtained at the symposium.

Some major species can resprout after the tops are scorched (*Ceratoides lanata*, *Kochia americana*, *Sarcobatus vermiculatus*); others must recover from seed (*Atriplex*

Table 1—Response of major perennial plants of salt-desert shrublands to fire

Species and Location		Lifeform ¹	Resprout	Killed (must regenerate from seed)
Uplands				
Spiny hopsage	<i>Atriplex (Grayia) spinosa</i>	S	X	
Budsage	<i>Artemisia spinescens</i>	S		X
Shadscale	<i>Atriplex confertifolia</i>	S		X
Little greasewood	<i>Sarcobatus baileyi</i>	S	X	
Fourwing saltbush	<i>Atriplex canescens</i>	S	X	
Torrey saltbush	<i>Atriplex torreyi</i>	S	X	
Gardner saltbush	<i>Atriplex gardneri</i>	H	X	
Winterfat	<i>Ceratoides (Eurotia) lanata</i>	H	X	
Gray molly	<i>Kochia americana</i>	H	X	
Forage kochia	<i>Kochia prostrata</i> ²		X	
Great Basin wildrye	<i>Leymus (Elymus) cinereus</i>	G	X	
Indian ricegrass	<i>Oryzopsis hymenoides</i>	G		X
Bottlebrush squirreltail	<i>Sitanion hystrix</i>	G	X	
Lowlands				
Black greasewood	<i>Sarcobatus vermiculatus</i>	S	X	
Samphire	<i>Salicornia utahensis</i>	H	?	
Torrey seepweed	<i>Suaeda torreyana</i>	H	?	
Iodine bush	<i>Allenrolfea occidentalis</i>	H	?	
Saltgrass	<i>Distichlis stricta</i>	G	?	
Alkali sacaton	<i>Sporobolus airoides</i>	G		X

¹S = shrub, H = half shrub, G = grass.

²Major introduced species used in revegetation efforts.

confertifolia, *Artemisia spinescens*) (table 1). This difference in response could drastically alter the course of secondary succession on these lands for many decades.

PROSPECTS FOR THE FUTURE

With the now wider presence of introduced annuals, I see increased chance of burning of salt-desert shrub rangelands. Global warming is expected to result in wider variations in temperature and precipitation. Thus, even though the longer term trends in temperature could be higher, we will probably have more extremely wet years as well as deeper droughts. This along with the fertilization effects of increased CO₂ should result in more fuel because cheatgrass and red brome (*Bromus rubens*) growth is enhanced by an atmosphere richer in CO₂ (Smith and others 1987).

Thus, unless we can use knowledge of when to expect wetter conditions from El Niño events to more successfully reseed these rangelands to less fire-susceptible perennials such as forage *Kochia* (*Kochia prostrata*), we are in for some more difficult times in managing some of the salt-desert shrublands.

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