Ecology and Management of Alien Annual Plants in the California Desert

by Matt Brooks and Kristin Berry

USDI, USGS, Biological Resources Division, Western Ecological Research Center, 6221 Box Springs Blvd., Riverside, CA 92507
matt_brooks@usgs.gov, kristin_berry@usgs.gov

Alien plants comprise a relatively small proportion of desert floras worldwide, and the deserts of California are no exception. Estimates of the proportion of alien plants range from 9 to 13%, compared to a global average of 16%. Although relatively few alien plants have invaded this region, the number is increasing and a select few now dominate many areas and negatively affect or threaten to affect ecosystem integrity.

The most studied alien plant species in the California deserts is the riparian perennial Tamarix spp., but riparian habitats comprise only 3% of the entire region and the remaining upland area is dominated by alien annual plants. Alien annuals often comprise 50-97% of the total annual plant biomass, and are present at virtually all sites. Thus, annuals are currently the most widespread and common alien plants in the California deserts.

Effects of Alien Annuals on Native Plants

Alien annuals can compete with native annual plants. Red brome, Mediterranean grass, cheatgrass, and red-stemmed filaree can all effectively compete with native annual plants for soil water and nitrogen. This competition leads to reduced density, biomass, and diversity of native annuals. Although it is unknown if an alien annual species could completely displace a native species, a previously common native annual grass, six-weeks fescue (*Vulpia octoflora*), became uncommon after the invasion of the ecologically similar Mediterranean grass during the middle 1900s.

Plant litter created by alien annual grasses decomposes more slowly than that of native annuals and accumulates during successive years. Alien grass litter can inhibit germination of native annuals by shading the soil, reducing the amount of water that reaches the soil, and suspending seeds above and out of contact with the soil. Experimental removal of alien grass litter increases density and diversity of native annuals.

Alien annuals can indirectly affect native plants by increasing the frequency of wildfires. Stems of alien annual grasses remain rooted and upright through the summer fire season and into successive years, whereas those of most native forbs crumble soon after they senesce. High frequency and cover of dead alien grasses facilitate the spread of fire in an otherwise fire-resistant landscape. Soil nutrient levels often increase after desert fires, thereby facilitating the reestablishment of alien annual grasses and promoting additional fires. Recurrent fire can convert high diversity native desertscrub into low diversity alien annual grassland.

Effects of Alien Annuals on Native Animals

Little is known about effects of aliens on native animals. With increasing diversity and biomass of alien annuals, food chains of native herbivores and omnivores and the composition and structure of vegetation in habitats are being altered. Potential negative effects include reduced availability of preferred food plants, loss or reduction of available nutrients and trace elements, and change in seasonal availability of plant foods. The desert tortoise, a threatened species in Mojave and Colorado deserts, provides one example of potential impacts. The tortoise is an herbivore and prefers native annual and herbaceous perennial plants to alien annual plants. For example, in the western Mojave Desert where alien grasses and forbs typically form over 50% of the available biomass of annual plants, native plants comprise 95% of the desert tortoise diet. The Mohave ground squirrel, a rare endemic species of the western and central Mojave deserts, may have similar forage preferences for native plants. The awns and spines of some alien plants pierce the guts and skin of domestic animals and may have similar deleterious effects on the health and survivorship of native animals.

Bromus rubens in a burned area, Opal Mountain, San Bernardino, California.

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Alien annual plants can alter the microstructure of desert habitats. Alien annual grasses such as Mediterranean grass can form dense mats in the beneath shrub and intershrub spaces, impeding the movements of small lizards and other animals, reducing availability of nest sites for birds, and altering ground temperatures. The often dense and persistent stands of bromes, mustards, and Russian thistles may have a similar effects. Several species of desert lizards depend on open environments for high speed travel, escaping predators, and finding prey items and mates. Increased annual plant cover in habitats invaded by aliens may limit the population sizes, health, and ultimately, the distribution of vertebrates.

"Changes in global climate may encourage the invasions of exotic annual species in the California deserts."

As mentioned above, alien plants contribute to increasing frequency and size of fires in the California deserts. These fires reduce shrub cover, change food availability for wildlife, and fragment habitat. For example, fires are reducing the quality of desert tortoise Critical Habitat. Desert tortoises require cover of shrubs for protection from temperature extremes and predators, and for burrows sites. About 70% of tortoise burrows are under the canopies of large shrubs, particularly creosote bushes. Alien-induced fires also reduce habitat structure in some desert plant communities. Joshua trees often die if burned, potentially diminishing habitat for wood rats, phainopeplas, kestrels, shrikes, cactus wrens, desert spiny lizards, and desert night lizards.

Future Trends

Changes in global climate may encourage the invasions of exotic annual species in the California deserts. Increased levels of atmospheric CO_2 have increased over 25% since pre-industrial times worldwide, and CO_2 concentrations in the atmosphere are expected to double before the end of the 21st century. Increased CO_2 is known to enhance production of rapidly-growing cool season species such as alien annual grasses and forbs.

Climatologists predict increased summer rainfall in the California deserts over the next century. Current periods of high rainfall promote the spread of alien annuals and the buildup of dead biomass that leads to increased fire frequency during subsequent years. The northern and western regions of the California deserts currently have little summer rainfall, and increased amounts during summer may open up these areas to invasion by warm season alien plants.

Deposition of atmospheric nitrogen from air pollutants can benefit alien plants, especially in the California deserts where low nutrient levels appear to be a major impediment to invasion. Even small increases in available nitrogen (3.2 g/m^2/yr) can increase density and biomass of aliens, and decrease density, biomass, and diversity of native annuals in the desert. Deposition rates of 4.5 g/m2/yr have been recorded in the Los Angeles basin, and are associated with high dominance of alien annual grasses and the loss of native shrub communities there. Although current deposition rates are undoubtedly much lower in the desert, future rates there will likely increase as human population and air pollution levels rise.

Management Needs

Land managers have limited control over some of the trends described above, but there is still much that they can do to manage alien plants.

Coordination among Land Managers. Weed management is most effective when efforts transcend jurisdictional boundaries to encompass entire ecoregions. Coordination is most effective at preventing new invasions, which is critical in the California deserts where the number of alien species is still relatively low.

Develop a List of Alien Species Already in the Region. A few land managers have begun to develop lists, but all should join in this effort to determine the extent of the alien plant problem and to identify hotspots of invasion.

Develop a List of Potential Invaders. The most reliable predictor of species invasiveness in the California desert appears to be invasiveness in similar habitats elsewhere. By assessing the invasiveness of plants in deserts worldwide and evaluating the patterns of world trade that may bring these species to the California deserts, we can compile a list of potential invaders. As incipient populations of these species are found, we will already know their potential for spread and thus their priority for control.

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Establish a Monitoring Program to Detect New Invaders. Monitoring may focus on hotspots for invasion, such as along roads, washes, or at the urban-wildland interface. Coordination among land managers is particularly important, because monitoring is useless if some managers fail to identify new invasions and allow them to become established in the region.

Develop Remote Sensing Techniques for Alien Annuals. Although these techniques may not be sensitive enough to reliably detect new invasions, they may be extremely useful in monitoring species that are already widespread or locally abundant.

Evaluate the Mechanisms of Plant Invasion. Much research is still needed to describe the characteristics that make species invasive and habitats invasible.

Evaluate Effects of Aliens on Threatened and Endangered Plants and Animals.
More research is essential to determine effects of aliens on threatened and endangered taxa, especially those living in threatened habitats or characteristic of wide-spread ecosystems, and to ensure that recovery efforts will be effective.

Evaluate Effects of Aliens on Ecosystem Integrity. If we are to understand ecosystem-level effects of aliens and develop appropriate management actions, then we need to step up ecosystem-level research, especially while some potentially alien-free sites still remain to serve as control sites.

Develop Methods to Control Alien Plants. Mechanical weeding or herbicide application are options for small infestations, and these may be the preferred methods to control incipient populations of new invaders. Biological control agents are the only feasible option for widespread alien plants, but very little bio-control research is conducted for alien annuals that infest wildland areas. In any case, land managers should carefully consider what species may replace any alien plant targeted for control, and if removal of an alien will result in positive ecological change.

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