Overcoming the Challenges of Desert Revegetation - Part I

By Leah Gardner

The desert. Hot. Dry. Windy. Rocky. Not the most hospitable environment for growing plants. Yet the desert is not a uniform, barren wasteland. Hundreds of species of plants and animals have evolved to live here in a surprising variety of life forms, niches and habitats.

The Mojave Desert is the largest desert in California, covering about one fifth of the state and supporting 1,400 species of plants. The Sonoran Desert, also known as the Colorado, is lower and warmer, but receives more summer rainfall. Over 700 species of native plants are found here. Average annual rainfall in the deserts is generally less than eight inches and often falls in widely spaced, intense events that can cause erosion and flash flooding.

The desert region is also home to the majority of California's active mines. When it comes to mine reclamation, techniques designed to capture precipitation, thereby increasing soil moisture, can greatly improve the success of revegetation efforts.

Re-surfacing Techniques

Shaping the surface by creating depressions that concentrate water dramatically increases seedling survival and plant establishment in arid ecosystems. Several innovative techniques have been developed over the last 3 decades suitable for economical desert reclamation. The main methods are ripping, imprinting, and pitting but several names have been applied to a range of site preparation strategies aimed at manipulating the seedbed environment. Land sculpting, moon-scaping, surface roughening, water harvesting, or creating "safe sites", "microcatchments" or "flower pots" are all names you may come across in the reclamation and restoration literature. A variety of machinery and implements are used to employ these measures including tractors, backhoes, scrapers, plows, tines, disks, and imprinting rollers.

Ripping involves pulling steel shanks through soils to break up compacted layers. This method helps to reduce the detrimental impacts of compaction and increase precipitation use efficiency. Compacted soils reduce infiltration, which leads to increases in runoff and erosion. Compacted sites recover very slowly on their own because it is difficult for plants to become established. Haul roads, processing locations and other heavily used areas of mines are especially prone to soil compaction. Recommended depths for deep ripping are between 12 and 36 inches.

Caterpillar tractor with ripping shanks.

Imprinting uses heavy rollers to make an irregular furrow pattern in the soil surface. This method provides better infiltration and penetration of rainfall by increasing the roughness and openness of the soil surface. A summary of the beneficial functions of land imprinting are: 1) water collection and infiltration 2) plant material mulching 3) soil firming 4) resource trapping and funneling and 5) shielding seedlings from the extremes of the macroclimate. Soil imprinting has the added benefit of controlling runoff, erosion and sedimentation. While imprinting is effective on steep or rough terrain, it is not suitable where soils are very rocky.

Pitting is a surface sculpting treatment used to create depressions that serve as rain catchment areas, increasing soil moisture and providing "safe sites" for seedling establishment. The capture and retention of precipitation in the pits can range from two to ten times that of open, untreated slopes. The best size and shape for the pit design should be determined by taking into account a variety of site-specific factors: soil type, slope, rainfall characteristics, runoff rate, requirements of species to be planted, and equipment availability.

The microenvironment within the depressions provides seedlings with some added protection from the desiccating effects of hot sun, dry wind and sand blast. Additional benefits of soil pitting are enhanced erosion control and a more natural appearance of treated slopes that blends in with the surrounding topography compared to that of straight engineered slopes. The appearance of the "viewshed" is particularly apparent in open desert environments, with their unobstructed panoramic vistas. While trees and shrubs can disguise mine features in other habitats, there is little cover to hide disturbances in arid landscapes.

David Bainbridge, associate professor at San Diego State University and leader of the Desert Restoration Task Force, calls soil pitting "The most effective low cost method of dry land recovery". Bainbridge recommends that, "Pitting should be more commonly selected as the preferred method for treating large areas of degraded lands and impacted soils in arid regions".

Shaping the ground to capture and concentrate available rainfall has been very effective for vegetation establishment in deserts. As one Southern California mine operator put it, "This simple land-sculpting technique gave us high value at low cost." Combined with the right choice of plant materials and the judicious application of soil amendments -- which will be discussed in Part II of this article in the next issue -- well-designed site preparation strategies are the best approach to overcoming the challenges of desert revegetation.

The roughened surface of this waste pile looks more natural than a smooth graded slope would. Shrubs are growing well in the bulldozed catchment basins, which concentrate rainfall and increase infiltration.

Overcoming the Challenges of Desert Revegetation - Part II

By Leah Gardner Miller

Soil Amendments

The addition of amendments and mulches to salvaged and redistributed topsoil may increase germination and plant establishment in any ecosystem, especially deserts. Mulches add organic matter to the soil, increase rainfall infiltration and retention, reduce evapotranspiration, decrease competition from weeds, and generally improve the soil and the microclimate around the plant. For desert applications, choose a type of mulch that is composed of large pieces or of heavier materials: these will deteriorate more slowly and be more wind resistant than lighter materials. Soil shaping techniques that create depressions will also trap blowing silt, seed, and plant materials, adding to the accumulation of mulch.

Desert soils are often low in nutrients and a laboratory soil analysis may recommend the application of fertilizer. However, the addition of fertilizers tends to promote invasive exotic plants, which can reduce native plant establishment and survival. Therefore, fertilizers are often unnecessary. When they are used, they should be of a low-potency, slow-release type.

Plant Materials

Due to the unpredictable, infrequent precipitation, plant establishment and growth is slow and sporadic in arid ecosystems. Plant density and cover are usually low and shrubs are usually the dominant life form. Seeds of most native desert plants are long-lived, able to take advantage of favorable conditions for germination once they do occur. A wet winter can send forth a burst of growth and colorful annual wildflowers can carpet the otherwise barren desert floor.

Taking these conditions into account, it is reasonable to assume that achieving your revegetation success criteria may take longer in the desert than in other environments – perhaps up to ten years. One restoration specialist speaking at the “Mojave Desert Revegetetion Symposium” held in Las Vegas this past April stated that good plant growth could only be expected on an average of one out of every three years. This means that revegetation will require patience and long-term monitoring.

Temporary irrigation can speed up the process, but is often impractical on large desert mine sites. Setting realistic targets should be tied to baseline surveys conducted in undisturbed habitats near the mine site. Targets for cover, density, and species richness can be set at about one-third of baseline numbers. Different targets should be set for different site conditions such as north versus south facing slopes versus desert wash. A high rate of seeding (measured in PLS– Pure Live Seed - per acre) and a wide variety of local species should be used to help insure success. Seed collection should begin early, since seed production will also vary year to year.

Only perennial species can be used in measuring success, since annuals are ephemeral and highly variable year to year. However, this does not imply that your seed mix should be comprised exclusively of perennials. Annuals, such as island plantain (*Plantago insularis)*, are important components of seed mixes, especially for erosion control. Grasses and forbs can provide needed cover while the slower-growing shrubs are getting established. Some desert plants, such as cacti, succulents, and yuccas such as Joshua trees, can be salvaged and transplanted if the correct procedures are carefully followed.

And unfortunately, arid ecosystems are not immune to invasion by exotic weeds. Among the major problem weeds to be on the alert for in the Mojave region are Russian thistle or "tumbleweed" (*Salsola tragus*), Sahara mustard (*Brassica tournefortii*), cheat grass (*Bromus tectorum*), and salt cedar or tamarisk (*Tamarix ramosissima*).

SOME PLANTS FOR MOJAVE DESERT REVEGETATION

Common name	**Latin name**
SHRUBS and SUB-SHRUBS:	
Creosote bush	*Larrea tridentata*
Saltbush (many species)	*Atriplex spp.*
Burro-weed	*Ambrosia dumosa*
Brittlebush, Incensio	*Encelia farinosa*
California buckwheat	*Eriogonum fasciculatum*
Cheesebush	*Hymenoclea salsola*
Brickelbush	*Brickellia*
Goldenbush	*Ericameria sp.*
Sweetbush	*Bebbia juncea*
Mojave Croton	*Croton californicus var. mohavensis*
GRASSES and HERBS:	
Six-week fescue	*Festuca octoflora*
Big galleta	*Pleuraphis rigida*
Indian ricegrass	*Acnatherum hymenoides*
Purple three-awn	*Aristida purpurea*
Alkali sakaton	*Sporobolus airoides*
Fluff grass	*Erioneuron pulchellum*
Desert plantain	*Plantago ovata*
Arizona lupine	*Lupinus arizonicus*
Stiff-haired lotus	*Lotus strigosus*
Freckled milkvetch	*Astragalus lentiginosus*
Desert mallow	*Sphaeralcea ambigua*


OMR botanists measure the success of creosote bush, four-wing saltbush, and other desert perennials in these “flower pots” created by sculpting the land at this reclaimed gold mine.

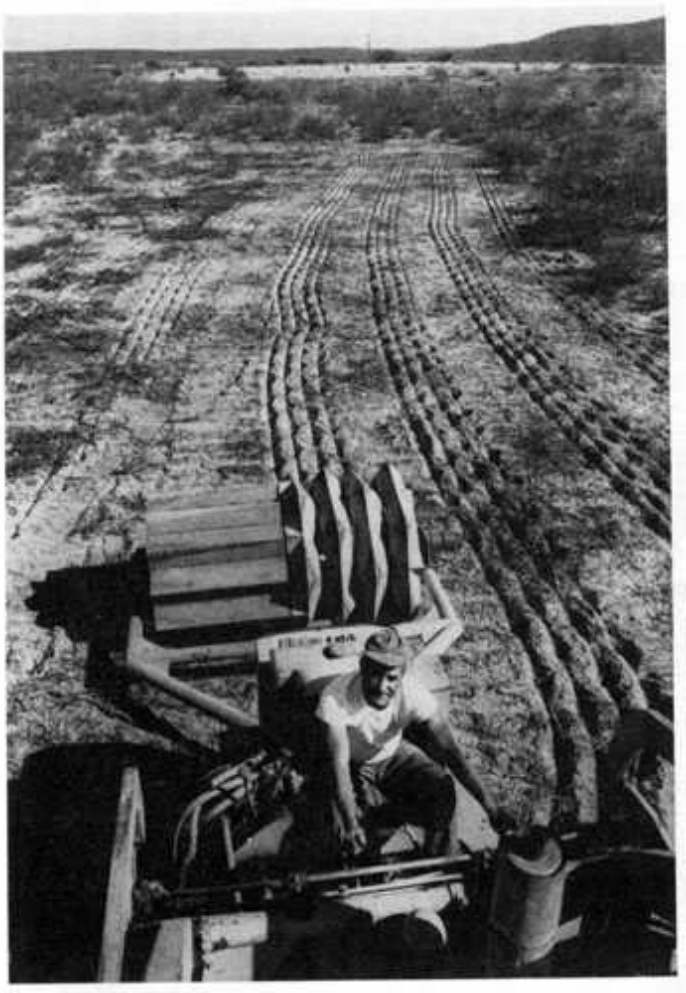
For more information on desert restoration, http://www.ecocomposite.org/restoration/index.htm
Also read “A Beginner’s Guide to Desert Restoration” by David Bainbridge, et al. at http://www.mycorrhiza.org/bainbridge.pdf

Case Studies

A five-year shrub establishment study, conducted by the Colorado Department of Natural Resources, Division of Minerals and Geology, compared different revegetation treatments at three coalmine sites in sagebrush scrub habitats. Surface roughening using a dozer to create depressions was included on several of the treatments along with different applications of topsoil and various planting schemes. The best results for shrub establishment and cover came from the plots with the surface roughening.

OMR botanists recently visited two large reclaimed gold mines in Imperial County. Both sites had employed the soil pitting strategy to create what they called "flower pots". The monitoring data for both sites showed that they had successfully met or exceeded their performance criteria for shrub cover, density and species richness. Our follow-up inspections revealed that the reclaimed slopes more closely resembled the vegetation characteristics of the washes than of the nearby hillsides.

What about transplanting cactus, Joshua trees, etc.?



The imprinter marks are relatively small compared to depressions formed by pitting, but both methods produce similar benefits.