The AZNPS Led Waterman Restoration Project:
Helping the Sonoran Upland Desert to Heal Itself

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The Setting

The Waterman Mountains are a rare limestone desert uplift 30 miles northwest of Central Tucson within the confines of the Ironwood Forest National Monument (IFNM) and administered by the Bureau of Land Management (BLM). The Waterman's are home to several alkali loving plants including the federally listed endangered species the Nichol's Turk's head cactus (*Echinocactus horizonthalonius* var. *nicholi*), elephant tree (*Bursera microphylla*), ocotillo (*Fouqueria splendens*) and desert agave (*Agave deserti*). The Waterman bajadas are dominated by saguaros (*Carnegiea gigantea*), foothill palo verdes (*Parkinsonia microphyllum*), and ironwood trees (*Olnea tesote*) with an understory of diverse grasses, forbs, and cacti. Desert bighorn sheep (*Ovis canadensis* ssp. *nelsoni*), desert tortoise (*Gopherus morafkai*), as well as many species of desert birds thrive in the Watermans.

Land Disturbance and Invasive Introduction

In March 1981 Harlow Jones, a mining entrepreneur and small aircraft salesman, illegally bulldozed 18 acres of undisturbed desert bajada on the northwest side of the Watermans. The disturbance included a one-kilometer airstrip. Starting in 1982 Mr. Jones lived on-site with his family, until he was declared a trespasser by BLM in 1997 and forced to leave. BLM requested that Mr. Jones plant vegetation on the disturbed land. Mr. Jones responded by planting buffelgrass (*Pennisetum ciliare*). By 2005 the entire 18 acres as well as 10 acres of peripheral desert were heavily infested with buffelgrass.

Initial Attempts To Control Buffelgrass

There were recurrent efforts to control the buffelgrass. Sierra Club whose volunteers manually removed plants (2005-2009), and BLM contracted for annual herbicide sprayings (2008-2009). But the soil remained charged with seed, and there was regrowth whenever there was sufficient rainfall and warm weather (Feb-March and July-October).

In June 2010, the Tucson BLM field office organized heavy-equipment to reshape and contour the entire site. In July 2010, the Arizona Native Plant Society (AZNPS) began a volunteer restoration effort and the recovery of the site began in earnest.

Tree Seeding

In the summer of 2010 AZNPS volunteers harvested palo verde and ironwood pods, along with whitethorn acacia (*Vachellia constricta*) seeds. In August and September of 2010 the volunteers planted the pods and seeds directly without any chemical treatment or seed scarification. By mid-September well over 2000 tree seedlings emerged. During the following six years, there has been an ongoing effort

to plant seeds in gaps where trees have not emerged. In addition to the tree species, volunteers have harvested and planted seed of ocotillo, prickly pear (*Opuntia engelmanii*), and triangleleaf bursage (*Ambrosia deltoidea*). BLM has given ANPS permission to annually harvest saguaro seed and broadcast those into the dripline of growing palo verde and ironwood trees. No irrigation or supplemental water has been brought to any plants on the restoration site since the beginning of the project. By 2016, some of the trees seeded in 2010 exceed 6 feet in height and are bearing seed. A tree inventory made in May 2016 resulted in a count of over 2500 trees. Tree seedlings are culled where their density is greater than trees in adjacent desert.

Bringing Buffelgrass Under Control

BLM provided backpack sprayers and glyphosate herbicide to AZNPS for buffelgrass control on IFNM. By mid-August 2010, after the site had been contoured with heavy equipment, the entire restoration site had sprouted in buffelgrass seedlings. AZNPS-led volunteers spot sprayed young buffelgrass plants three times weekly from August through October. No buffelgrass plants were allowed to flower. Volunteers were trained to identify look-alike native grasses so they could carefully direct spraying only at buffelgrass plants. Buffelgrass spraying continued every year with a sharp drop-off of buffelgrass plants emerging each year. Total herbicide applied in 2010 was 234 gallons and by 2014 the total applied was only 3 gallons for the same area. By 2016 only a few plants are still found and have been easy to identify and pull out manually.

Fixing Problem Areas

Four major problem areas covering two out of the total 18 acres were identified with little or no plant growth. Soil analyses were conducted on the recommendation of a UA soil scientist. The conclusion was that there was no soil toxicity problem but rather a soil moisture-holding limitation. This limitation could be corrected with the construction of bermed terraces and one-rock dams to capture and retain runoff water. During a five-year period, over 150 structures were built with over 2000 hours of volunteer manpower. There was a dramatic plant establishment and growth response to the enhanced moisture in and adjacent to the bermed terraces and one rock dam. Volunteers made sure that runoff water would spread and soak in rather than pool in one area. In areas where water was allowed to pool, there was poor plant emergence and growth. There were large upland bare ground patches across the site where no plants emerged. According to an infrared thermometer mid-June, afternoon, soil temperatures averaged 145 F˚. Bare areas overlaid with tree and brush cuttings averaged 115 F˚. Based on that difference, and also the fact that shaded soil dries out more slowly than soil in the full sun after rainfall, project leaders decided to amend the bare soil with tree and brush cuttings. Over a five year period approximately 300 pickup truck loads of tree branches were hauled onto bare areas with a marked increase in plant establishment within 24 months.

Native Species and Vegetative Coverage

Plant species on the site were routinely noted. Vegetative coverage, other than the planted tree seeds, resulted from seed coming from adjacent desert areas. Currently, 102 native species have been identified. This list includes 20 native grass species and one spontaneously occurring Nichols Turk's head cactus discovered in April 2016. At the outset of the project in 2010, seven 50-meter transects were established. Vegetative coverage and species counts are made each year in mid-October. By 2016 the vegetative coverage had plateaued at 61%, with little change in the overall coverage from year-to-year as numerous small grasses were replaced by larger perennial plants. Five photo-points were established and a set of repeat photographs have been taken annually in mid-October.

Plant Establishment and Succession

A few species were noteworthy in their rapidity and extent of early establishment: woody crinklemat (*Tiquilia canescens*), brittlebush (*Encelia farinosa*), purple and six-weeks threeawn grass (*Aristida purpurea* and *A. adscencionis*), fluffgrass (*Dasyochloa pulchella*), and globemallow (*Sphaeralcea ambigua*). In spring 2016 two Nichol's Turkshead Cacti had established in the runway area of the site. All of the seed was either in situ or blown in from the adjacent desert.
Two species were notable for their contribution of copious amounts of plant litter to the bare soil, fluffgrass and trailing four-o'clock (*Allionia incarnata*). Both of those species germinated and grew all year long whenever there was sufficient moisture available. Both species regularly died off and provided litter and ground cover, allowing for germination of successional species such as hoary abutilon (*Abutilon incanum*) and triangleleaf bursage (*Ambrosia deltoidea*). By 2016 there was an obvious succession of brittlebush yielding to triangleleaf bursage. This succession was expected as triangleleaf bursage is a dominant shrub and brittlebush is rare in adjacent undisturbed deserts.

Fauna Establishment

In 2010 and 2011 only two vertebrate animal species were regularly seen, rock wrens and coachwhip snakes. By 2014 black-throated sparrows were already nesting in prickly pear and young palo verde trees. A few blacktail rattlesnakes were found and whiptail lizards appeared throughout the site. The first Harris’s antelope squirrels were sighted. By 2016 there were extensive rodent holes and ant colonies. Desert bighorn sheep regularly began grazing on the site.

Discussion and Conclusions

Within a six-year period, a near monoculture of buffelgrass was eliminated and an Upland Sonoran plant community was well on its way to re-establishment. Repeated and careful spot spraying of the buffelgrass made room and available moisture to native plants without further ground disturbance. By the fourth year, herbicide application was negligible. Woody-tree species planting from seedpods proved to be very effective. While there was never any hand watering or artificial irrigation, the trees and shrubs have benefited from the extensive water harvesting effort that resulted in keeping most of the rainfall and incoming runoff on the site itself. No seed mixes were planted. All of the species now growing on the disturbed area share the same genetics (not just species commonality) as native plants in adjacent deserts.

Bulldozing and scraping of the soil by Mr Jones resulted in a depletion of organic matter and soil surface litter. The soil disturbance also resulted in poor water permeability. The accumulation of plant litter, especially from native grasses has resulted in gradually growing plant associations and enhanced water penetration. The extensive amendment of tree brush as well as an amendment of significant litter from the woody degradation has enhanced plant growth. It took six years before widespread rodent, lizard, and ant holes appeared. Those holes will continue to enhance water penetration and retention in future years. Newly established palo verde trees started bearing seedpods in 2015 and that seed pod and tree litter production will increase in multiples over future years, providing habitat for nurse plants and fauna.

This effort has spanned six years and included approximately 5000 dedicated volunteer hours. Had the effort followed the typical 2- or 3-year project life cycle without sustained continued effort, the land would have reverted to buffelgrass, and erosion channeling would have left most of the area dry and barren. Year after year, buffelgrass seedlings were removed, erosion channels were rocked as they

appeared, berm terraces were repaired and reinforced, and bare areas were covered with brush and replanted with tree seed.

This project demonstrates that timely interventions can indeed reclaim the desert from buffelgrass invasions and other disturbances and put in place the essential ingredients for desert regeneration. But focused attention, hard work, and multiple years are required.

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