

HEALTH OF PLANTS AND SOIL SALVAGED FOR REVEGETATION AT A MOJAVE DESERT GOLD MINE¹

by

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Abstract. Viceroy Gold's Castle Mountain Project in the East Mojave National Scenic Area 60 miles south of Las Vegas will cumulatively affect 890 acres of vegetation at the mine site and an additional 25 acres of land on the access route to the mine. Reclamation will be conducted concurrently with mining activity to increase the success of revegetation efforts. At the Castle Mountain Project reclamation begins as a site is prepared for mining use, the first stage being plant salvage. To date more than 11,000 plants from 15 plant species have been salvaged from approximately 300 acres and placed in nurseries, with barrel cactus (*Ferocactus acanthodes*), and Joshua tree (*Yucca brevifolia*) comprising approximately 80% of the salvaged plants. Plants will be maintained in the nurseries until used in revegetation. Of the 5109 plants surveyed so far, 75% have been rated as being in excellent condition with 9% mortality. Joshua trees are the most sensitive to transplanting and do best if transplanted with a tree spade during the winter months. The second stage of reclamation is salvage of topsoil, referred to here as "growth media" due to a lack of a discernable A horizon in the soils in the mine area. To date approximately 334,050 cubic yards of growth media has been stockpiled for use in revegetation. Viability of vesicular-arbuscular mycorrhizal fungal propagules will be assayed using the inoculum unit method which provides a quantitative measure of inoculum potential that can be used to assess whether the inoculum potential of the stockpiles is decreasing. A viable microflora in the stockpiles is crucial to the ability of the growth media to support plant life when used in revegetation. Viceroy's commitment to reclamation is unique and is being documented in detail for the benefit of future mining activities in desert ecosystems.

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Introduction

Viceroy Gold's Castle Mountain Project, located in California's East Mojave National Scenic Area, 75 miles south of Las Vegas Nevada will cumulatively affect 890 acres of land at the mine and an additional 25 acres of land on the access route to the mine. In February 1992 Viceroy poured its first gold bar. By this stage in mine operations over 10,000 plants and over 250,000 cubic yards of growth media had been salvaged for future reclamation use. To date over 11,000 plants and 330,000 cubic yards of growth media have been

salvaged. The plants are maintained in nurseries and the growth media is stored in stockpiles until needed for revegetation efforts.

Reclamation begins as the site is prepared for use, the first stage being plant salvage. The use of salvaged plants in reclamation will greatly increase reclamation success by placing established plants into a desert ecosystem where seedling establishment is rare. Barrel cactus (*Ferocactus acanthodes*) and, Joshua tree (*Yucca brevifolia*) currently make up approximately 80 % of the salvaged plants. The second stage of reclamation is salvage of growth media. Soil microflora, particularly vesicular-arbuscular mycorrhizal fungal propagules decrease over time in soil stockpiles (Miller et. al. 1985, Rives et. al. 1980). If the rate of decrease is high before use, the growth media is no longer a good medium for plant growth.

The purpose of this paper is to report on efforts to quantify the health of salvaged plants and growth media. Quantifying salvage efforts at the Castle Mountain Project will aid future restoration efforts in desert ecosystems.

Methods

Salvaged Plants

The majority of the salvaged plants have been placed in two nurseries at the minesite. Several hundred of the plants have already been planted in revegetation sites. All plants are being placed into a database such that there will be data on each individual plant including: species name, transplant date, location, and treatment. Treatments include: watering (present or absent), method of transplantation (post hole, bare root, tree spade etc.), and superthrive, a root stimulant (present or absent). Health of plants will be assessed yearly and recorded as excellent, poor or dead. This data set will allow assessment of transplant shock as well as long term survival in the nurseries.

Salvaged Soil

The growth media stockpiles have been cored in three places to three depths. The subsamples from each stockpile will be assessed by the infection unit method (IUM) of vesicular-arbuscular mycorrhizal propagule determination (Franson and Bethlenfalvay 1989). The IUM provides a direct assessment of fungal hyphal entry points into roots under controlled conditions that can be used for comparing stockpile samples to each other and to samples from undisturbed areas near the stockpiles. By sampling the stockpiles yearly, any decline in mycorrhizal propagules can be assessed quantitatively. Similarly, the effect of any treatments to the stockpiles can be assessed also.

Results

Salvaged Plants

To date 5109 plants of 13 species have been assessed. The health of the plants is tabulated by species in Table I. The overall mortality is 9%. Three quarters of the plants are rated as being in excellent condition. For barrel cacti, the plant salvaged in the highest numbers, 84% of the plants were rated as being in excellent condition. For the barrel cacti, a rating of excellent was given if there was no discoloration of the tissue anywhere on the plant. Dead barrels rot from the inside out and give a hollow sound when kicked. For Joshua trees, the second most salvaged plant, only 40% of the plants were rated as excellent. For Joshua trees, a rating of excellent was given if the tissue had a deep green color, a rating of poor was given if all or part of the foliage was a yellow-green color, and a rating of dead was given if no green tissue was evident anywhere on the plant. Because foliage color has to be assessed, Joshuas were harder to qualitatively rate than any other species. At this point in time we have no way of knowing whether the Joshua trees rated poor are dying or will recover. Similarly, those rated dead due to a lack of green foliage may also recover by sprouting new foliage. A breakdown

Table I. Health of Salvaged Plants by Species

Species	Common Name	Health			Total
		excellent	poor	dead	
<i>Ferrocactus acanthodes</i>	barrel cactus	2973 (84)	239 (7)	336 (9)	3548
<i>Yucca brevifolia</i>	Joshua tree	344 (40)	492 (56)	34 (4)	870
<i>Opuntia erinacea</i>	old man cactus	126 (86)	21 (14)	0	147
<i>Echinocactus polycephalus</i>	cottontop cactus	112 (86)	17 (13)	7 (7)	136
<i>Opuntia basilaris</i>	beavertail cactus	70 (58)	30 (25)	21 (17)	121
<i>Yucca shidigera</i>	mojave yucca	74 (67)	12 (11)	24 (22)	110
<i>Yucca baccata</i>	blue yucca	50 (82)	3 (5)	8 (13)	61
<i>Echinocereus engelmannii</i>	hedgehog cactus	41 (93)	1	3 (7)	45
<i>Opuntia chlorotica</i>	pancake cactus	34 (92)	3 (8)	0	37
<i>Opuntia phaeacantha</i>	mojave prickly pear	12 (100)	0	0	12
<i>Opuntia echinocarpa</i>	silver cholla	10 (83)	0	2 (7)	12
<i>Larrea tridentata</i>	creosote bush	11 (100)	0	0	11
<i>Acacia greggii</i>	catclaw	2 (100)	0	0	2
Total		3857 (75)	817 (16)	435 (9)	5109

numbers in parentheses are percentages.

of Joshua tree health by location, transplantation method and date of transplant is presented in Table II. When Joshua trees are transplanted in the winter or spring and are tree spaded, the success of transplanting is very high. However, if the trees are transplanted during the summer, even tree spaded plants do poorly. Application of Superthrive to promote root growth does not appear to have a positive effect on Joshua tree roots.

Discussion

Data on approximately 45% of the salvaged plants shows that Mojave desert plants can be transplanted and maintained with high success for more than a year and a half. The species most sensitive to transplanting (Joshua tree) can be transplanted with very high success if it is moved during the winter with a tree spade, with the most crucial factor being the season in which it is transplanted.

Literature Cited.

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Table II. Health of Salvaged Joshua Trees (*Yucca brevifolia*) by treatment

Date Planted	Transplant Method	Location	Super-thrive	Rodent Damage	Health			Total
					excellent	poor	dead **	
April-May 91	Post Hole	ground	---	---	246 (35)	437 (61)	30 (4)	713
April 91	Tree Spade	box	---	---	12 (100)	0	0	12
July 92	Tree Spade	box	---	---	16 (41)	23 (59)	0	39
April-May 91	Post Hole	ground	Yes	---	227 (34)	416 (62)	30 (4)	673
April-May 91	Post Hole	ground	No	---	19 (48)	21 (52)	0	40
May 91	Post Hole/ Trench	ground	---	Yes *	30 (26)	82 (71)	4 (3)	116

* rodents chewed through drip tubing on the irrigation system.

** no green tissue present

numbers in parentheses are percentages