

Health of Plants Salvaged for Revegetation at a Mojave Desert Gold Mine: Year Two

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Abstract—At Viceroy Gold's Castle Mountain Mine in the East Mojave Desert, Joshua trees and barrel cacti are salvaged before disturbance and maintained in two nurseries for later outplanting to revegetation sites. The plants are assessed each year on a qualitative scale. In the 1993 survey, 7,941 plants were rated. Joshua trees that were salvaged by hand showed only 4% mortality in the nursery each of the first two years. A comparison of Joshua tree health in the two nurseries showed that the Joshua trees in the south nursery had a higher percentage rated as being in poor health. This is attributed to problems with the irrigation system in the south nursery. Barrel cacti had 9% mortality in the first year and 7% mortality in the second year. Barrel cactus plots in undisturbed areas were established in 1993 to compare death rates in the nursery to death rates under natural conditions. Joshua trees and barrel cacti can both be transplanted by bare rooting in large numbers and maintained in nurseries in high densities for at least two years. The data on these nurseries is useful for anyone attempting salvage of *Yuccas* or barrel cacti for restoration or landscaping purposes.

Even under the most favorable conditions, seedling establishment for most plant species in desert systems is a rare event. This poses a problem for reclamation efforts in desert systems. In recognition of this, Viceroy Gold Corporation salvages Joshua trees (*Yucca brevifolia*), barrel cacti (*Ferocactus acanthodes*) and several other plant species ahead of disturbance to land at the Castle Mountain Mine in the East Mojave Desert in southeast California. To date, over 10,000 live plants have been salvaged and are being maintained in two nurseries at the mine. In September 1992 and June 1993 the health of plants in the nurseries was assessed on a qualitative scale. The health of 7,941 plants that were salvaged in 1991 and 1992 were assessed in 1993 (Table 1).

Very little is known about the growth of Joshua trees (Rowlands 1978) and barrel cacti. Even less is known about transplantability of these plants. Franson and Bernath (1993) reported on the health of about 45% of the salvaged plants one year after transplanting and focused on the health of Joshua trees by season of salvage

and salvage methods. Joshua trees transplanted with a tree spade during winter had the best health rating. Joshua trees treated with Superthrive to promote root growth showed no improvement over trees transplanted without Superthrive.

This paper reports on the death rate of Joshua trees and barrel cacti, transplanted by bare rooting, two years after transplanting, providing the first large data set on survival of both species after salvage. *Yucca* sp. and barrel cacti are salvaged in the Mojave desert before a variety of disturbances and for various landscaping projects. Data collected at the Viceroy Gold nurseries will be useful to anyone attempting to salvage these plants

Methods

Salvage

Joshua trees between 3 and 8 feet tall with few branches are salvaged by hand digging. The bare roots are dusted with sulfur powder to minimize infection from airborne microbes. The trees are then planted in rows in the nurseries. The soil at the nurseries is better than most of the soils on site. Each row has a drip irrigation line for summer watering. Soil moisture in the rows is monitored by gypsum block soil moisture sensors. The Joshua trees are watered because their density in the nursery is much higher than their density in nature.

Barrel cacti small enough to be lifted by one person (up to about 15 inches in diameter) are salvaged by hand digging. The plants with bare roots are left to cure in the sun to minimize root infections. After several days of curing the cacti are planted in rows in the nurseries and grown without supplemental watering.

Plant Health

Plants are located by row and sequential position in the row and rated as being in excellent, poor or dead condition. By this method, improvement and decline in individual plants can be followed. For Joshua trees, an excellent rating is given if there is no yellowing of the leaves and they are rated as dead if they have no green leaves. For barrel cacti, an excellent rating is received if there is no yellowing of the tissue and they are rated as being dead if they have become hollow. Two plots in undisturbed areas, each containing 100 barrel cacti, were established in 1993 to compare the death rates in the nurseries to barrel cacti in the wild.

In: Roundy, Bruce A.; McArthur, E. Durant; Haley, Jennifer S.; Mann, David K., comps. 1995. Proceedings: wildland shrub and arid land restoration symposium; 1993 October 19-21; Las Vegas, NV. Gen. Tech. Rep. INT-GTR-315. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

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Table 1—Health of salvaged plants by species.

Species	Common name	Health			Total
		Excellent	Poor	Dead	
<i>Ferocactus acanthodes</i>	barrel cactus	3,718 (78) ¹	368 (8)	709 (15)	4,795
<i>Yucca brevifolia</i>	Joshua tree	523 (36)	811 (56)	113 (8)	1,447
<i>Opuntia erinacea</i>	old man cactus	80 (71)	25 (22)	8 (7)	113
<i>Echinocactus polycephalus</i>	cottontop cactus	250 (82)	33 (11)	21 (7)	304
<i>Opuntia basilaris</i>	beavertail cactus	39 (46)	23 (27)	23 (27)	85
<i>Yucca schidigera</i>	Mojave yucca	623 (66)	150 (16)	166 (18)	939
<i>Yucca baccata</i>	blue yucca	160 (71)	34 (15)	32 (14)	226
<i>Opuntia chlorotica</i>	pancake cactus	20 (63)	10 (31)	2 (6)	32
	Total	5,413 (68)	1,454 (18)	1,074 (14)	7,941

¹Numbers in parentheses are percentages.

Results

Joshua Trees

The 1992 survey of 713 Joshua trees showed that 4% of the trees had died (Table 2). This number is much lower than was expected at the start of the salvage operation. How much of this 4% was due directly to transplant shock could not be determined from this single assessment. The same rows of Joshua trees were assessed in 1993. At the end of two years the total percent dead was 9%. Since Joshua trees are tallied by location, dead Joshuas are tallied each year. So, the 9% number means that 5% died in the second year, or approximately the same number as the first year. The similarity of the death rate in both years suggests that transplant shock was not a major cause of death.

The 1993 survey tallied 1,447 Joshua trees. In the north nursery 41% of the Joshua trees were rated as being in excellent condition (Table 3). This percentage dropped to 29% for Joshua trees in the south nursery. There were two major differences between the two nurseries during the first two years. The soil in the north nursery is better (deeper and less rocky) and the irrigation system worked better in the north nursery.

Table 2—Health of salvaged barrel cacti (*Ferocactus acanthodes*) by nursery.

Nursery	Health			Total
	Excellent	Poor	Dead	
North	2,978 (79) ¹	203 (5)	582 (15)	3,763
South	740 (72)	165 (16)	127 (12)	1,032

¹Numbers in parentheses are percentages.

Barrel Cacti

The 1992 survey of 3,295 barrel cacti showed that 9% of the cacti had died (Table 4). At the end of the second year the same rows showed 16% mortality (9% the first year and 7% the second). As with the Joshua trees, barrel cacti showed similar mortality in the first and second year.

The 1993 survey tallied 4,795 barrel cacti. The plants in the north and south nurseries showed similar health ratings (Table 5). This result suggests that the poor rating of the Joshua trees in the south nursery was due to lack of water and not soil since the barrel cacti were in the

Table 3—Health of salvaged Joshua trees (*Yucca brevifolia*) by nursery.

Nursery	Health			Total
	Excellent	Poor	Dead	
North	348 (41) ¹	432 (51)	66 (8)	846
South	175 (29)	379 (63)	47 (8)	601

¹Numbers in parentheses are percentages.**Table 4**—Health of salvaged barrel cacti (*Ferocactus acanthodes*) by year.

Years after transplanting	Health			Total
	Excellent	Poor	Dead	
1	2,796 (84) ¹	203 (7)	297 (9)	3,296
2	2,539 (78)	198 (6)	508 (16)	3,245

¹Numbers in parentheses are percentages.

Table 5—Health of salvaged Joshua trees (*Yucca brevifolia*) by year.

Years after transplanting	Health			Total
	Excellent	Poor	Dead	
1	246 (35) ¹	437 (61)	30 (4)	718
2	303 (41)	375 (50)	65 (9)	743

¹Numbers in parentheses are percentages.

Table 6—Health of barrel cacti at undisturbed sites.

Location	Health			Total
	Excellent	Poor	Dead	
North of Hart	93	0	7	100
Green and Gold	87	0	13	100
Total	180	0	20	200

same soil but not watered. The irrigation system problems have been remedied for the 1994 summer season.

To determine whether the barrel cacti death rate is similar to plants in the wild, plots were established in two areas that will not be disturbed by mining. In each plot 100 barrel cacti in the same size class as those in the nursery were

marked and their health was assessed (July 1993). In the initial survey, all plants were either rated excellent or dead (Table 6). These plots will be assessed each year when the nurseries are assessed.

Conclusions

Joshua trees and barrel cacti can be transplanted by bare rooting in large numbers and maintained in high density nurseries for at least two years with a very low death rate (4% for Joshua trees and 8% for barrel cacti). This allows both affordable salvage of areas that will be disturbed and the use of large numbers of plants up to 50 years old in revegetation and landscaping.

References

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