

Panel Discussion: Stocktypes for Outplanting in Zion National Park

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Introduction

Zion National Park is located in southwestern Utah at the junction of three geographic regions: the Mojave Desert, the Great Basin, and the Colorado Plateau. This unique geography creates distinctive habitats in Zion. With the Virgin River running through the middle of the park, Zion is a refuge for plants, animals, and humans as well.

You would think that restoration with native plants in their native habitat would be a simple job, particularly inside an agency without multiple use issues to contend with. But there are three major variables to contend with on every revegetation project. These obstacles have directed the Zion Vegetation staff towards specific stocktypes for successful outplanting of native vegetation grown at the Zion Native Plant Nursery.

Annual Precipitation

Zion's average annual precipitation is 15 in (38 cm). Unfortunately, this is not a reliable number. In 2002, at 4.8 in (12.3 cm), Zion had the lowest rainfall on record. In 2005, the highest rainfall on record occurred, more than 31 in (79 cm) (table 1). Due to staffing levels, supplemental water is next to impossible, so the highly unreliable moisture levels make revegetation with container stock problematic.

Annual Exotics

Riparian corridors are diverse, dynamic, and complex biophysical habitats that are especially critical in the arid regions of the southwestern U.S. Because these areas are literally oases in the desert, they attracted Euro-American settlers who took advantage of the relief and resources found there. Often, subsistence farming activities took place near riparian areas where water conveyance was made possible for irrigated crops. Unfortunately, this type of historic high intensity land and water use introduced many exotic plant species that, over time, have degraded these fragile ecosystems.

In what is now Zion National Park, centuries of grazing and farming combined with several years of drought have allowed exotics to invade and predominate in the Virgin River corridor. Approximately 70 percent of the canyon floor is currently infested with aggressive exotic annuals, predominately brome grasses (*Bromus tectorum* and *B. diandrus*) (figure D)

Table 1—Annual precipitation for Zion National Park in recent years (water year runs from October to September).

| Year | Precipitation | |
|-----------------|---------------|-------------------|
| 1999 | 13.0 | |
| 2000 | 9.0 | |
| 2001 | 13.5 | |
| 2002 | 4.8 | Lowest on record' |
| 2003 | 14.1 | |
| 2004 | 12.5 | |
| 2005 to 10 Sept | 31.2 | Highest on record |

^a 1 in = 25.4 mm



Figure 1—Single native plant (prickly poppy [*Argemone munita*] surrounded by a field of *Bromus diandrus*)

These annual exotics are able to out-compete the native vegetation, especially during drought years, by germinating early and depleting available soil moisture. When conditions are not favorable to brome grasses, or even when park staff are able to control the bromes through fire, manual, or chemical means, different annual exotics often invade by taking advantage of the resulting open space and disturbance.

Annual Visitation

Visitation in Zion National Park has more than doubled over the past 15 years to a record 2.7 million in 2004. This dramatic increase initiated development of the Zion Canyon shuttle system that operates from the end of March through October—Zion's busiest months. Prior to operation of the shuttle system, visitation in the main canyon was restricted to the limited number of available parking spaces. While the shuttle allows more public access to the most popular sites in Zion Canyon, it has also concentrated use around the seven shuttle stops within the canyon. This has resulted in heavy off-trail use in many areas. When just a few people travel off trail to form a "social trail," others often follow thinking that "it must be OK if other people are doing it," or "there must be something interesting over there." This often leads to severely eroded sites and trail damage (figure 2).

To mitigate this damage, the vegetation staff uses a variety of techniques including fencing, ropes and stakes, a "stick to the trail" campaign complete with stickers for children, and a variety of signs (figure 3). Our "Restoration Area—Please Stay Off" is the most effective sign in use, but

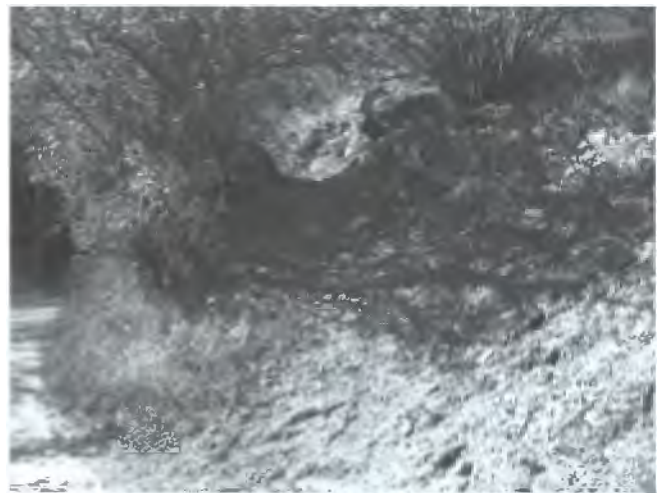


Figure 2—Damage and erosion caused by heavy off-trail use by visitors.



Figure 3—Attempts at the "stick to the trail" campaign to keep visitors out of fragile areas and to avoid off-trail use.

it only works in conjunction with plantings that are very obvious to the visitor. Trampling by visitors is not usually deliberate, but the signs clearly let visitors know that restoration work has occurred and that the plants are fragile and should not be stepped on.

Restoration in Zion National Park

Plant Requirements

For all of the aforementioned restoration obstacles, the vegetation staff at Zion has learned that bigger plants with deep roots are much more conducive to establishment for a number of reasons.

- 1) The well developed, deeper roots help the plants survive low precipitation years by utilizing the cooler and moister soil beneath the very hot, dry surfaces in the canyon. (Daytime temperatures in the summer months are often more than 110 °F [43 °C].
- 2) Larger plants fare better when competing with annual exotics for moisture and sunlight—the roots reach deeper into the soil profile and the leaves are less likely to be shaded by the fast-growing annuals.
- 3) Larger plants are more obvious to the visitors in conjunction with signs and are far less likely to be trampled.

Container Types

Because desert plants are usually deeper rooted than plants from other regions, the Zion Native Plant Nursery uses narrow, deep pots of various sizes for most of their non-riparian plants.

1) D40 Deepots™ Cells (2.5 in [6.4 cm] wide by 10 in [25.4 cm] deep, or 40 in³ [656 cm³]) are used for grasses, forbs, and some shrubs (figure 4). In addition to producing deep-rooted



Figure 4—D40 Deepots™ are used for grasses, forbs, and some shrubs.

plants, this system has the additional benefit of removable cells that allows for better spacing once plants are mature.

2) Tall One Treepot™ (4 in [110 cm] wide by 14 in [35.6 cm] deep, or 173 in³ [12.43 l]) are used for most shrubs (figure 5).

3) TPOT8 Treepots™ (11 in [28 cm] wide by 24 in [61 cm] deep, or 1,848 in³ [30.3 l]) are the containers of choice for nonriparian trees. However, benefits to tree establishment must be balanced with the additional labor required to dig holes big enough to plant trees of this size. An auger can drill adequate holes, but it must be transported to the site and operated by trained personnel (figure 6). Because most of Zion's outplanting is done by volunteers, outplanting with an auger is usually not feasible. For this reason, trees are often grown in TPOT2 Treepots™ (6 in [15 cm] wide by 16 in [41 cm] deep, or 380 in³ [6.31 l]) or TPOT4 Treepots™ (7.75 in [20 cm] wide by 18 in [46 cm] deep, or 588 in³ [9.6 l])

Because these pots are black and absorb radiant heat from the sun, which can overheat the rootzone, the pots placed in full sun for most of the summer are painted white by volunteers. Individual pots may be painted or larger pots that contain many pots may be painted (figure 7).

Outplanting

When outplanting, establishment has been enhanced by planting into a pocket slightly deeper than the soil surface—this helps funnel moisture to the root zone. We also mulch with wood chips (usually cottonwood) produced from fuel reduction projects near developed areas. This helps to prevent soil surface moisture loss.



Figure 5—Tall One Treepots are used for most shrubs.



Figure 6—Planting auger necessary for outplanting stock grown in large containers.



Figure 7—Individual pots or pots containing many pots painted white to reduce heat stress.

Projects

Not all of Zion's restoration projects are in arid environments. The Colorado Plateau is famous for hanging gardens where specialized moisture-loving flora and fauna live on wet walls and floors. Hanging gardens are formed when subsurface water contacts an impermeable geologic layer and seeps from vertical sandstone walls. This results in two specialized habitats: the wall itself and the wet floor below. In Zion, numerous hanging gardens are being degraded by an exponential increase in visitation. Riverside Walk, the most heavily used trail in the park and gateway to the famous Narrows hike, passes alongside several hanging gardens. The Riverside Walk trail can receive over 3,500 visitors each day between April and October. The Hanging Gardens there are cool, moist, and inviting in summer months when temperatures often exceed 100 °F (38 °C); as a result these unique places are subjected to the most concentrated visitation levels. Many of the garden floors are now denuded and the soil is heavily compacted by excessive trampling (figure 8). Additionally, these poor conditions

have led to invasion of nonnative plants in and around the gardens resulting in degraded endemic animal habitat and ecological function.

Thanks to a recent grant, Zion is currently working to restore some of these heavily visited hanging gardens. An interpretive sign is being developed, and some of the hanging garden floors have been fenced along the Riverside Walk trail. Rhizome cuttings of species that occur on both the walls and floor (maidenhair fern [*Adiantum pedatum*], cardinal monkey flower [*Mimulus cardinalis*], and Jones' reedgrass [*Calamagrostis scopulorum*]) were taken from the hanging garden walls in February and placed into 4-in (10-cm) by 14-in (36-cm) by 20-in (51-cm) Dyna-flatsimi (figure 9). These were grown in a shadehouse through the summer and will be cut into approximately 4-in (10-cm) "brownies" and planted into the wet hanging garden floors in the fall. With the fencing preventing trampling by visitors and plenty of water due to the seeping walls, the plants will thrive and should fill in the degraded areas in a relatively short period of time,



Figure 8—Damage to Hanging Gardens due to overuse in the summer months.



Figure 9—Maidenhair fern cuttings grown in Dyna-flat™.

Summary

The majority of revegetation and restoration occurs in the more arid and overused habitats of Zion National Park. After several years of trials to determine the best ways to overcome restoration obstacles, Park vegetation staff have

learned a number of lessons to aid in plant establishment, including: 1) grow plants with well-developed, deep roots; 2) grow plants as large as are feasible to outplant to combat trampling; 3) plant deep, that is, deeper than the soil surface and preferably in pockets to collect moisture; 4) mulch wherever possible; and 5) prevent trampling wherever possible.