



Pumice Desert Revegetation Project

2019 Annual Report





ON THIS PAGE

Off-road vehicle trespass in the Pumice Desert.

Photo by Jen Hooke

ON THE COVER

Damage to vegetation and soils by off-road vehicle trespass in the Pumice Desert.

Photo by Jen Hooke

Pumice Desert Revegetation Project

2019 Annual Report

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This annual report series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by a subject matter expert who was not directly involved in the collection, analysis, or reporting of the data.

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Abstract

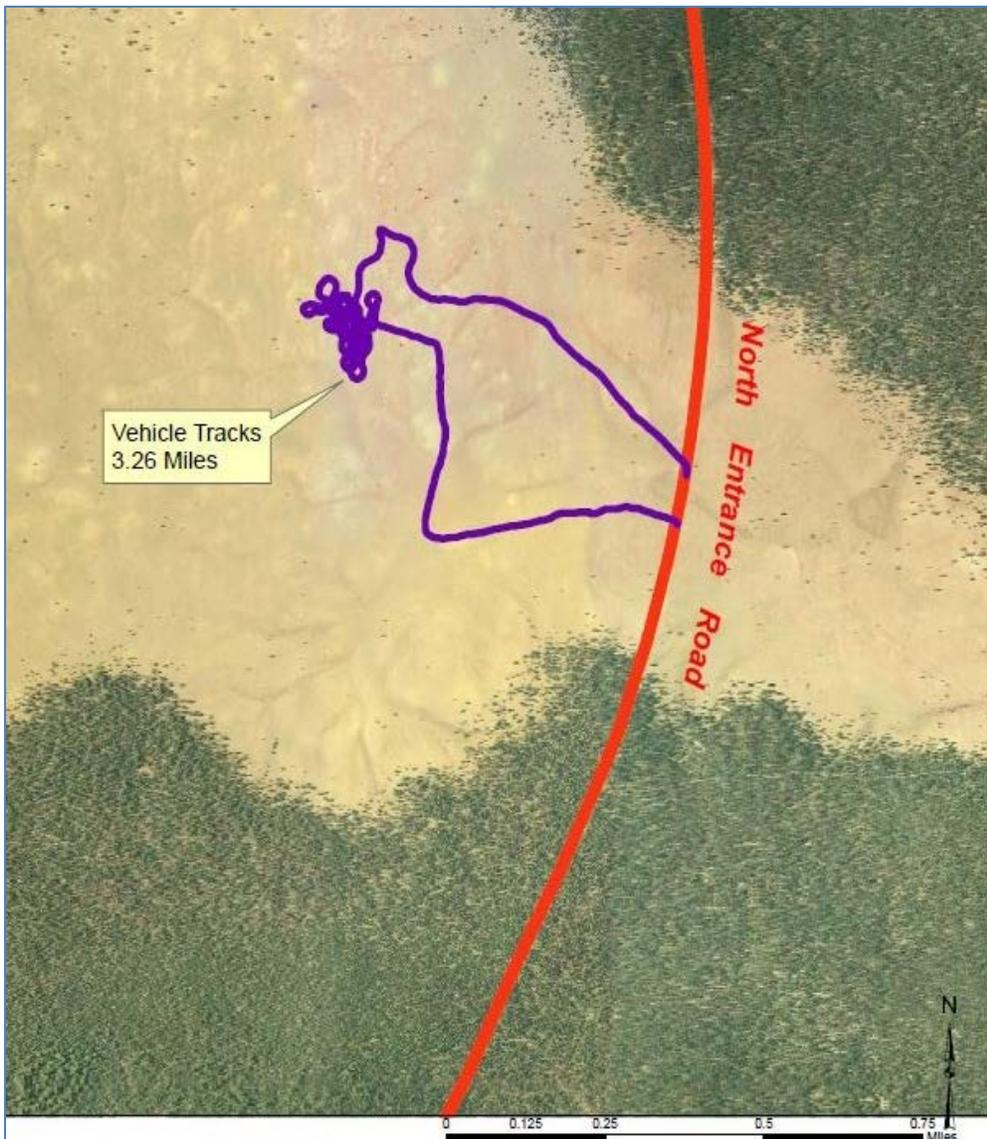
In 2018, a visitor to Crater Lake National Park was cited for illegally driving 3.26 miles off-road through the park's Pumice Desert area. The incident created large areas of deep, persistent ruts in the fragile pumice soil, killing most of the impacted vegetation within the tire tracks. Through the System Unit Resource Projection Act, the Botany program received funds to restore the damaged area to its pre-disturbance condition by smoothing out displaced soils, monitoring for invasive vegetation, and revegetating the area with locally sourced native plant materials through broadcast seeding and outplanting. Results of restoration efforts in 2019 include the development of revegetation prescriptions and plant material collection lists; collecting and processing 366 g of native seed; propagation of 396 native plants; smoothing out vehicle tracks; broadcasting 328 g of native seed; and monitoring for the establishment of invasive plant species.

Acknowledgments

The Pumice Desert restoration project was funded by the National Park Service Damage Assessment and Restoration program authorized by the System Unit Resource Protect Act (SURPA, formerly known as “19jj”). Karen Battle-Sanborn served as the Damage Case Officer throughout the claim process, and her assistance was invaluable in getting this restoration project off the ground. Caitlin Schauer and Alec Chapman helped shepherd this project through the SURPA process, and their patience and persistence is greatly appreciated. Melody Frederic, Carson Ralls, Benjamin Wright, Delacey Randall, Elena Olsen, Hamilton Hasty, Sarah Hogan, Vance McNees, and Matthew Jelinske helped with raking off-road vehicle tracks; Melody Frederic, Carson Ralls, Benjamin Wright, and the Friends of Crater Lake helped with seed collection and cleaning.

Introduction

On July 8, 2018, a Park visitor left the North Entrance roadway in his vehicle and drove 3.26 miles through the Pumice Desert area of Crater Lake National Park (CRLA). The visitor left not only vehicle tracks, but also made tight circles or “donuts” with his vehicle in several locations (Figure 1). The vehicle tracks alone damaged and killed vegetation and displaced soils; the “donuts” were extremely damaging to the site and left areas with deep (> 1’ deep – Figure 2) overlapping ruts that killed most of the impacted vegetation. Crater Lake National Park Law Enforcement staff were able to identify the visitor and issued him a citation.



The National Park Service (NPS) Damage Assessment and Restoration program helped CRLA staff recover costs for injuries sustained to vegetation and soils of the Pumice Desert as authorized under the System Unit Resource Projection Act. A Damage Case Officer was assigned to this incident, and assisted CRLA staff in preparing documentation and funding requests to support rehabilitation and restoration work.

Figure 1. Map of vehicle trespass tracks in the Pumice Desert. Map by Chris Wayne.

The purpose of the Pumice Desert Restoration project is to restore the area disturbed by off-road vehicle trespass back to its pre-disturbance condition. This is to be achieved by raking out vehicle tracks and destroying berms created by driving with hand tools; collecting native plant materials; and revegetating disturbed areas via broadcast seeding and outplanting. Additionally, the disturbed area will be surveyed for invasive plant establishment.

The Pumice Desert is a unique feature within CRLA, as it emerges as a treeless expanse amid a forested landscape. During the cataclysmic eruption of Mt. Mazama approximately 7,700 years ago, the Pumice Desert area was covered with pumice and glowing avalanche deposits exceeding 200' in depth in some places (Horn 2009). The



Figure 2. Depth of “donut” tracks exceeded one foot in places. Photo by Jen Hooke.

well-drained pumice, sand, and gravel deposits have been slow to weather; therefore, soils are young and infertile (Horn 1968). The surface of the Pumice Desert experiences wide fluctuations in diurnal temperatures, and the plant species tolerating these harsh conditions have developed adaptations to help them retain moisture and survive extreme temperatures (Horn 1968). Due to these challenging growing conditions and slow rate of plant succession and tree establishment, the Pumice Desert was established as one of the Park’s Research Natural Areas (RNA) in 1991. Additionally, portions of the Pumice Desert fall within the Park’s recommended wilderness.

Methods

Revegetation efforts are categorized into two main emphasis areas: (1) those focused directly on revegetation such as site prescription documentation, collecting and processing native seed, propagating plants for outplanting, preparing soils, and seeding the site; and (2) invasive vegetation management.

Revegetation

Site Prescription

The first step in revegetation planning was gathering information about the native plant species present in the Pumice Desert. This area is a relatively flat expanse of pumice, sand, and gravel with a relatively even cover of low-growing herbaceous plant species that are adapted to harsh climates. While total plant cover is relatively low, during peak bloom the Pumice Desert turns yellow and red with Sierra eriogonum and Newberry's fleecflower, illustrating a continuous albeit subtle mantle of vegetation (Figure 3).

Isolated lodgepole pine (*Pinus contorta* var. *latifolia*) saplings dot the Pumice Desert landscape; however, none occurred within the restoration project area. A comprehensive plant species list for the Pumice Desert had already been developed by long-term monitoring efforts (Horn 2016) (Table 1).



Figure 3. The Pumice Desert tinted yellow at peak bloom from Sierra eriogonum flowers. Photo by Jen Hooke.

Table 1. Plants of the Pumice Desert RNA (Horn 2016).

Common name	Scientific name
Needlegrass	<i>Achnatherum occidentale</i>
Newberry's fleecflower	<i>Aconogonon davisiae</i> var. <i>davisiae</i>
Howell's flatseed rockcress	<i>Boechera howellii</i>
Pussypaws	<i>Calyptridium umbellatum</i>
Brewer's sedge	<i>Carex breweri</i>
Hall's sedge	<i>Carex halliana</i>
Rayless Shasta aster	<i>Dieteria canescens</i> var. <i>shastensis</i>
Common squirreltail	<i>Elymus elymoides</i> ssp. <i>elymoides</i>
Pumice sandwort	<i>Eremogone pumicola</i>
Greene's goldenweed	<i>Ericameria greenei</i>
Sierra eriogonum	<i>Eriogonum marifolium</i> var. <i>marifolium</i>
Dwarf hulsea	<i>Hulsea nana</i>
Cascade desert parsley	<i>Lomatium martindalei</i>
Prostrate lupine	<i>Lupinus lepidus</i> var. <i>lobbii</i>
Lodgepole pine	<i>Pinus contorta</i> var. <i>latifolia</i>
Goosefoot yellow violet	<i>Viola purpurea</i> ssp. <i>venosa</i>

From the initial plant species list, a revegetation prescription for the Pumice Desert restoration area was developed (Table 2) based on the abundance of plant species present in adjacent, intact plant communities. Relative cover values were determined by ocular estimates.

Table 2. Site prescription for Pumice Desert project area.

Seed Zone: Pumice Desert		ID: PD	Unplanned site
Location: Pumice Desert			
Site Description: 3.26 miles of damaged area on the west side of the North Entrance road in the Pumice Desert RNA.			
Pre-Disturbance Site Information			
Scientific Name	Common Name	Relative % Cover	
<i>Achnatherum occidentale</i>	Needlegrass	10	
<i>Aconogonon davisiae</i> var. <i>davisiae</i>	Newberry's fleecyflower	15	
<i>Boechera howellii</i>	Howell's flatseed rockcress	5	
<i>Calyptridium umbellatum</i>	Pussypaws	8	
<i>Carex breweri</i>	Brewer's sedge	8	
<i>Dieteria canescens</i> var. <i>shastensis</i>	Rayless Shasta aster	5	
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	Common squirreltail	10	
<i>Eremogone pumicola</i>	pumice sandwort	12	
<i>Ericameria greenei</i>	Greene's goldenweed	5	
<i>Erigogonum marifolium</i> var. <i>marifolium</i>	Sierra eriogonum	7	
<i>Lomatium martindalei</i>	Cascade desert parsley	5	
<i>Lupinus lepidus</i> var. <i>lobbii</i>	Prostrate lupine	10	
Total Cover		100%	
Associated species: <i>Hulsea nana</i> , <i>Pinus contorta</i> var. <i>latifolia</i> , <i>Viola purpurea</i> ssp. <i>venosa</i> , <i>Carex halliana</i>			
Total Vegetative Cover: 15%		Elevation: 5,950 ft.	
Slope: 0	Aspect: N/A	Snowmelt out: early June	
Soil "hardness," presence of rocks: Pumice			
General Soil description: Sandy pumice			
Ameliorating microsite features: none			
Wind exposure: High		Canopy cover (overall): none	
Area: 3.26 miles			
Comments: Species cover and composition are varied throughout.			
Recorders: CW, SH			
Date: 8/14/19			

Native Seed Collection and Processing

Using the revegetation prescription as a reference, seed was collected from grasses and forbs within a mile of the project area within the Pumice Desert. Seed collection in 2019 targeted the most abundant plant species in the project area, and ones that the Botany program has experienced the most success with propagating and planting in prior restoration projects. The seed collection process commenced in 2019 by observing and documenting the phenology of each targeted species in the project area (Table 3).

Table 3. Pumice Desert phenology during the 2019 field season. No phenology data were taken before 6/18, as the road was still closed from winter snow.

Common Name	Scientific Name	Leaf	Bud	Flower	Fruit	Seed
Needlegrass	<i>Achnatherum occidentale</i>	6/18	7/08	7/15	7/22	7/29
Newberry's fleecflower	<i>Aconogonon davisiae</i> var. <i>davisiae</i>	**	**	6/18	7/01	7/22
Howell's flatseed rockcress	<i>Boechera howellii</i>	**	**	6/29	7/08	7/29
Pussypaws	<i>Calyptridium umbellatum</i>	**	**	6/18	7/01	7/22
Brewer's sedge	<i>Carex breweri</i>	6/18	7/01	7/15	7/29	8/06
Hall's sedge	<i>Carex halliana</i>	**	**	6/18	7/01	8/06
Rayless Shasta aster	<i>Dieteria canescens</i> var. <i>shastensis</i>	6/18	7/01	7/22	8/01	8/12
Common squirreltail	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	6/18	7/08	7/15	7/22	8/06
Greene's goldenweed	<i>Ericameria greenei</i>	6/18	7/22	8/12	9/09	9/23
Sierra eriogonum	<i>Eriogonum marifolium</i>	**	6/18	6/24	7/22	8/18
Pumice sandwort	<i>Ermogone pumicola</i>	**	**	6/18	7/01	8/6
Dwarf hulsea	<i>Hulsea nana</i>	**	6/18	6/24	7/08	7/22
Cascade desert parsley	<i>Lomatium martindalei</i>	**	**	6/18	7/01	8/06
Prostrate lupine	<i>Lupinus lepidus</i> var. <i>lobbii</i>	**	**	6/18	7/08	7/22

** *Data unavailable*

Seeds were collected according to the Botany program's established Seed Collection Protocols (Beck et al. 2017). Seed was dried and cleaned according to the Botany program's Seed Cleaning and Short-Term Storage Protocol (on file on the Botany server). Limited seed collected from individual species was reserved for use in plant propagation. Remaining seed was cleaned, mixed with park-sourced compost, and dispersed and raked into the disturbed areas.

Plant Propagation

Propagation of native plants from seed poses difficulties for the Botany program due to the lack of equipment for cold stratification of seeds and the year-round staffing required for early season plant care. To address these difficulties, plant propagation techniques utilize CRLA’s abundant snowpack to cold stratify seeded pots, and the plant propagation schedule aligns with the present Botany field season.

In October of 2019, Ray Leach “SC7 Cone-tainer” pots were placed in racks and then filled and settled to 0.5” below the top rim with Premier “PRO-MIX HP Mycorrhizae” soil. These pots were then seeded with a small pinch of native seeds collected from the project area during the 2019 field season. A thin (~1/8”) layer of soil was then placed over the seeds, and the pots were watered (Figure 4).

The seeded pots were placed under rodent-excluding screens in the Botany program’s Ball Diamond nursery at Park headquarters and left to overwinter under the snowpack to replicate natural germination conditions (Figure 4). Prior to overwintering, pots were placed in a tight group, and mulch was packed around the perimeter to protect roots from exposure to severe cold and desiccation.



Figure 4. Seeding pots for propagation (left). Seeded pots under rodent-excluding caging (right). Photos by Carrie Wyler.

Soil Rehabilitation

Prior to planting or seeding a disturbed site, efforts are made to prepare the site for restoration. Since the Pumice Desert restoration site was disturbed by illegal vehicle trespass (some areas with severe impacts), site preparation entailed raking out vehicle tracks and donut areas to restore natural

conditions as much as possible/practical. This work was slow-going and required a delicate approach to avoid impacts to living vegetation. Raking occurred in the fall when plants were dormant.



Figure 5. Botany crew raking out tracks and raking seed into disturbed areas in the Pumice Desert project area. Photo by Carrie Wyler.

Planting and Seeding

A mix of plant species will be planted in the disturbance areas in accordance with the prescriptions and actual availability of plant materials. After planting, compost will be added, and plants will be watered. A site-specific seed mix was prepared and hand-broadcast over disturbed and subsequently raked areas. After broadcasting seeds, the sites were scarified with hand rakes and compost was broadcast over the scarified areas (Figure 5).

Invasive Vegetation Management

Given the project area location, invasive vegetation management (IVM) stands as a critical component of a successful revegetation effort. IVM efforts include conducting area surveys and controlling invasive plant species, both before and during rehabilitation efforts. See the 2019 IVM Annual Report (Randall et al. 2020) for detailed methodology on invasive plant survey and control. Historic invasive plant populations were investigated using the IVM program's geodatabase, which maintains invasive plant records from 2003—present. Any invasive plant species encountered are treated as per the Park's Invasive Vegetation Management Plan (DOI NPS 2017).

Results

Revegetation

Site Prescription

Botany staff developed a revegetation prescription (Table 2) for the Pumice Desert area that will serve as baseline information that guides which plant species are used to restore the vegetation communities that had been destroyed by off-road vehicle trespass.

Native Seed Collection and Processing

Seed was collected from six plant species during the 2019 season, and a seed mix was created from nine less abundant species (Table 4). The plant species included in the seed mix were pumice sandwort, Howell's flatseed rockcress, Brewer's sedge, Hall's sedge, rayless Shasta aster, Greene's

goldenweed, Sierra eriogonum, dwarf hulsea, and goosefoot yellow violet. Seed was dried at the seed drying facilities in the Stall Nine garage at Park headquarters and cleaned in the Rat Hall garage bay. Collecting seed for this project proved challenging, as seed availability in the Pumice Desert is much less abundant than other restoration project areas. This may be due to the harsh growing conditions present in the Pumice Desert, which results in a low number of seeds being produced by plants under duress. A large amount of time was spent searching the area for available seed without exceeding seed collection thresholds established to leave enough seed *in situ* for natural regeneration and wildlife sustenance.

Table 4. Seed collection amounts in 2019 for the Pumice Desert revegetation project.

Common Name	Scientific Name	Seed collected in grams
Needlegrass	<i>Achnatherum occidentale</i>	15
Newberry's fleecflower	<i>Aconogonon davisiae</i> var. <i>davisiae</i>	26
Pussypaws	<i>Calyptridium umbellatum</i>	4
Common squirreltail	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	113
Cascade desert parsley	<i>Lomatium martindalei</i>	11
Prostrate lupine	<i>Lupinus lepidus</i> var. <i>lobbii</i>	1
Seed mix	n/a	196
Total		366

Plant Propagation

Three plant species were targeted for plant propagation efforts by seed in 2019 (Table 5). A total of 308 pots were seeded in October of 2019 and are presently in cold stratification under the snowpack at the Ball Diamond. Germination and establishment success will be evaluated during the 2020 field season.

Table 5. Number of plants propagated in fall 2019 for the Pumice Desert revegetation project.

Common Name	Scientific Name	# of plants propagated	Amount of seed used (grams)
Needlegrass	<i>Achnatherum occidentale</i>	198	2
Newberry's fleecflower	<i>Aconogonon davisiae</i> var. <i>davisiae</i>	98	6
Common squirreltail	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	98	3
Total		396	11

Soil Rehabilitation

In October 2019, 11 Botany staff members spent an entire day raking out vehicle tracks, decompacting disturbed soil, blending disturbed soils in with the slope and appearance of the natural area, and obliterating and smoothing out any berms or other unnatural features created by off-road vehicle trespass in the project area (Figure 6).



Figure 6. Botany crew member smoothing out large ruts and berms created by off-road vehicle trespass. Photo by Carrie Wyler.

Planting and Seeding

Since funding to support revegetation and restoration of this area was not received until August 2019, no planting occurred this season. A Minimum Requirements Analysis was prepared to allow restoration planting in areas that were disturbed by off-road vehicle trespass in the Park's recommended wilderness. A seed mix was created using excess seed not needed for the 2019 fall propagation efforts and is in storage for use in 2020. In total, 328 g of native seed was broadcast seeded in the disturbed area.

Invasive Vegetation Management

The only invasive plants detected in the Pumice Desert area during 2019 were found in the island between the Pumice Desert Overlook and the North Entrance Road. This island harbored small populations of field bindweed (*Convolvulus arvensis*), common dandelion (*Taraxacum officinale*), and purple anther field pepperweed (*Lepidium heterophyllum*). This island was partially buried under gravel during a 2014 Pavement Preservation project, and the invasive plants were most likely introduced at that point. All invasive plants encountered were treated in 2019, and the entire area will continue to be surveyed for invasive plant species in 2020.

Discussion

The significance of the Pumice Desert area clearly justifies an active restoration approach to correct resource damage inflicted by off-road vehicle trespass. Without management actions, the floristic, Resource Natural Area, and wilderness values would be impacted for many decades to come.

The 2019 field season laid the foundation for revegetation efforts at the Pumice Desert project area. A Revegetation plan was developed, native seeds were collected, damaged areas were raked and seeded, and plant propagation initiated to provide the first pulse of plant materials needed to restore the damaged landscape back to the highly sensitive and significant native plant community. Lessons learned from recent revegetation projects such as the Rim Drive Rehabilitation Revegetation project and the Pacific Crest Well Pipeline Revegetation project guided efforts made on the Pumice Desert Revegetation project. Seed collection in 2019 targeted species that are easy to collect from and provide abundant seed (Wylers et al. 2019). Plant propagation techniques used were ones with which the Botany program has had prior success (Heisler et al. 2019).

The 2020 field season will require continued seed collection and plant propagation efforts. Seed collection from plant species in this area is extremely time consuming because of limited seed production. Extra time should be allowed to collect seed to ensure there is enough to meet target goals. Plant propagation success needs to be evaluated in summer of 2020 and adjustments made to ensure adequate plant establishment and growth. The project area will need continued survey for and treatment of invasive plant species.

Continued monitoring in coordination with CRLA Law Enforcement staff for new vehicle tracks in the Pumice Desert area will need to happen in 2020 on a regular basis. Raking out any new tracks that materialize helps prevent other Park visitors from getting ideas that they, too, should drive off the road into this sensitive area. Consideration should be given to installing barriers along the entire span of the North Entrance Road through the Pumice Desert in order to keep vehicles from damaging this fragile area. This is truly the only way to protect this sensitive area and allow its unique plant community to flourish.

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