



# Rim Drive Rehabilitation Revegetation Project

## *2017 Annual Report*





**ON THIS PAGE**

Working on site documentation for the Rim Drive Rehabilitation project.  
Photograph by Carrie Wylar.

**ON THE COVER**

Collecting native plant seed for restoration while the Spruce Fire plumes in the background.  
Photograph by Carrie Wylar.

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# **Rim Drive Rehabilitation Revegetation Project**

## ***2017 Annual Report***

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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.

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## **Abstract**

Crater Lake National Park's Rim Drive Rehabilitation Revegetation project aims to mitigate impacts to the rim environment from the Federal Highway Administration-sponsored Rim Drive Rehabilitation project. This major construction project is correcting many deficiencies present along the Park's historic Rim Drive. Through surveying for and controlling invasive plant species, salvaging and reestablishing rare plant populations disturbed by the construction project, and restoring disturbed areas using site-specific native plants and seed it is hoped that long-term impacts from this construction project to the Park's natural resources will be minimized. During the 2017 field season, over 51,281 invasive plants were removed from the project area. Additional rare plants were salvaged from areas prior to disturbance from construction activities and incorporated into a holdover facility where plants are monitored for health and survival. For the fifth year in a row, plant materials were collected from five distinct seed zones representing the floral diversity of the project area. Fifty-seven seed accessions were provided to the Corvallis Plant Materials Center by Park staff and contract crews for propagation of plants for revegetation and creation of customized seed mixes for each restoration site. Site documentation was refined for each disturbed site to inform future restoration efforts and monitor revegetation status of the project. In 2017, CRLA staff planted 363 native plants and dispersed 406 grams of native seed throughout disturbed areas along East Rim Drive. On West Rim Drive, 924 native plants were outplanted in disturbed areas along with approximately 357 salvaged rare plants; and 1,597 grams of native seed were broadcast in disturbed areas along the road corridor. Scheduled construction work for 2017 was not completed this season, leaving much restoration work to be accomplished during the 2018 field season.

## **Acknowledgments**

This project was greatly assisted by staff at the National Park Service Denver Service Center, notably Tracy Cudworth, Chris Taliga, and Ken Stella. Jim Kent of the Federal Highway Administration assisted with translating construction plans into tangible impacts that helped direct mitigation efforts and communicating changes in the project schedule and timeline. The Crater Lake National Park Maintenance staff allowed use of the Ballfield at Park headquarters for storing and caring for salvaged and delivered plants, and the South Yard for maintaining facilities for plant propagation and seed cleaning. The Crater Lake National Park Roads crew provided large equipment and staffing to prepare ground for increase seed beds, move large items, and turn large piles of compost for use in restoration efforts. Assistance with seed collection and invasive plant survey and control was provided by Kathryn Williams. Planting assistance was received by members of the Crater Lake National Park Invasive Vegetation Management crew, especially Lindsay Crouch, Rachel Wheatley, Delacey Randall, Katie Ripstein, Sarah Hall, and Michael Hernandez. Staff at the Corvallis Plant Materials Center, especially Amy Bartow, provided technical assistance with seed collection techniques. The Institute for Applied Ecology provided assistance with seed collection.

## Introduction

The Federal Highway Administration (FHWA)-sponsored Rim Drive Rehabilitation and Rockfall Mitigation project is a multi-year endeavor to enhance and improve Crater Lake National Park's (CRLA) historic and scenic Rim Drive and its associated pullouts and parking areas. The 29.4 mile long Rim Drive is a popular Park road and destination; it provides seasonal access to the caldera rim with its many trailheads and scenic vistas of Crater Lake and the surrounding Cascade Range. Rim Drive is listed on the National Register of Historic Places and has been nominated as a cultural landscape. Rim Drive was completed in 1941, and occasional repairs have occurred in the years since its construction. However, major reconstruction is now occurring as existing roadway materials have exceeded their lifespan, and the roadbed and associated masonry features have deteriorated due to erodible soils and years of harsh weather.

The first phase of this project was conducted in 2014 and focused on intensive rockfall mitigation using heavy equipment and rock scaling at Wizard Island Overlook, the Watchman, Sun Grade, Dutton Cliffs, and the Anderson Cut. The current phase of the Rim Drive Rehabilitation project commenced in 2015 and affects at least 6 miles of West Rim Drive, portions of East Rim Drive (e.g., North Junction to Cleetwood Cove; Skell Head; Grotto Cove), and the Rim Village parking lot. Several new disturbance areas were established in 2016 and 2017 along West and East Rim Drives resulting from activities such as deep patch work, road realignment, and correcting drainage issues (Appendix A). In addition to impacting roadways and road shoulders, numerous pullouts, parking areas, and parking lots are being modified. These modifications include obliterating unofficial pullouts (Figure 1), shrinking the footprint of excessively large parking areas, and installing landscaping islands in high visitor use areas. Additionally, road work displaced the world's largest known population of the Crater Lake rockcress (*Boechea horizontalis*), a rare plant that is a Species of Concern on the federal endangered species list, and a candidate species for listing as threatened or endangered by the state of Oregon.



**Figure 1.** One of the pullouts (right) slated for obliteration and restoration along West Rim Drive. Photo by Jen Hooke.

Due to the substantial impacts occurring to soils and vegetation, FHWA has funded efforts to restore affected areas through revegetation, special status plant species management, and invasive vegetation management. The Rim Drive Rehabilitation Revegetation (RDRR) project is tasked with:

1. Developing revegetation prescriptions for disturbed areas to be restored.
2. Surveying for and controlling non-native, invasive plant species within the project area.
3. Salvaging, transplanting, and monitoring special status plants impacted by the project.
4. Collecting native plant seed and materials for revegetation efforts.
5. Restoring affected areas through site preparation, planting, and seeding.
6. Monitoring restored areas for revegetation efficacy and augmenting restoration actions as necessary.

Restoration of areas disturbed by the Rim Drive Rehabilitation project (Figure 2) is necessary to jumpstart natural succession of vegetation communities and will help protect the rim environment from soil erosion and invasion by non-native plant species. Through using site-specific, native genotypes in revegetation efforts, the biodiversity and genetic integrity of the rim vegetation community is maintained. Additionally, as Rim Drive is a popular Park road, revegetation will yield aesthetic benefits to Park visitors by reducing the appearance of bare, disturbed ground throughout the project area. As of November 2017, road construction crews have completed deep patch operations on East Rim Drive; rehabilitated West Rim Drive from Rim Village north to North Junction; and completed the Rim Village parking area. Work on the Cleetwood parking lot and trailhead is ongoing and still not completed as of November 2017. One of nine pullouts along East Rim Drive has been obliterated, and four out of fifteen pullouts on West Rim Drive have been obliterated (two need additional soil contouring work prior to restoration). Much of the work in 2017 was hindered by a late snowmelt, multiple large fires, and early-season snow storms. Work in 2018 will focus on obliterating all remaining pullouts; completing the Cleetwood Cove parking lot and trailhead renovations; finishing renovation of the Watchman Overlook; starting rehabilitation of Roundtop Quarry and other staging areas; and finishing up other sites within the project area. The types of areas to be restored along with their restoration status are listed in Table 1.



**Figure 2.** Collecting seed and conducting restoration outplantings for the Rim Drive Rehabilitation project. Photos by Carrie Wyler.

**Table 1.** RDRR restoration areas by location and completion status as of November 2017.

<b>General Location</b>	<b>Type of Site/Location</b>	<b>Number to Restore</b>	<b>Restoration Complete?</b>
West Rim Drive	Obliterated Pullout	15	2/15 complete
West Rim Drive	Reduced Footprint of Parking Area (Lightning Springs, Last Snow, Glacial Valley)	3	No
West Rim Drive	Rare Plant Population Reestablishment (Watchman)	1	Yes
West Rim Drive	Unplanned Disturbed Areas*	3*	Yes*
West Rim Drive	Landscaping Island (Watchman Overlook)	2	No
East Rim Drive	Obliterated Pullout	9	No
East Rim Drive	Roadway Realignment (Pumice Point, Grotto Cove)	2	Yes
East Rim Drive	Landscaping (Cleewood Cove Parking Lot and Trailhead)	2	No
East Rim Drive	Rare Plant Population Reestablishment (Grotto Cove)	1	Yes
East Rim Drive	Llao Rock staging area	2	No
East Rim Drive	Roundtop Quarry	1	No
East Rim Drive	Unplanned Disturbed Areas	19	17/19 complete

*\*Additional disturbance areas may be added during the 2018 season as a complete assessment was not feasible in 2017.*

Five seasonal Biological Science Technicians (Plants) were devoted to the RDRR project in 2017; season length was from May 1 – November 9. In addition to working in areas directly impacted by the Rim Drive Rehabilitation project, the RDRR program also surveyed areas that were used for staging of project materials and equipment for invasive plant species. Staging areas include two pullouts on East Rim Drive, Roundtop Quarry, the Ballfield, and Pole Bridge Creek Quarry.

Efforts made by the RDRR program in 2017 can be organized into three components: (1) revegetation; (2) special status plant management; and (3) invasive vegetation management; these are described below.

## **Methods**

Methods for each component of the RDRR program are discussed separately.

## Revegetation

### **Site Prescriptions**

Prior to construction, revegetation prescriptions were developed for each area slated for restoration starting in 2012 (Figure 3). These prescriptions serve as documentation of the pre-disturbance site features and plant species composition unique to each area. Prescriptions were developed by making visits to each site and recording the dominant plant species with an ocular estimate of each species' relative cover value. This documentation was established with the intent that it would inform revegetation efforts by providing a baseline from which to determine the number of plants and amount of seed to be used at each site. The specifics of this process are outlined in a project-specific Revegetation Plan (Gregory et al. 2015).

The 2013-2017 RDRR crews continued to develop prescriptions and make adjustments as unanticipated resource disturbance necessitated the addition of new restoration sites. Because the pre-disturbance vegetation community for these sites was destroyed and unavailable for use as a reference, revegetation prescriptions were developed from adjacent areas. As of November 2017, 56 restoration sites have been established, each with a unique revegetation prescription. Documentation of these prescriptions can be found in Botany program files at Park headquarters (R:\BOTANY\Ecological Restoration\Rim Drive Rehabilitation project\Revegetation\Site documentation).



**Figure 3.** Developing revegetation prescriptions for disturbed areas. Photo by Scott Heisler.

### **Seed Collection**

The project area was delineated into seed zones, with each serving as a distinct area where seeds and propagated plants could be sourced and moved without compromising genetic integrity. In defining seed zones, sites with similar vegetation communities were grouped together - these groupings corresponded to similarities in site location and elevation. Five seed zones (Figure 4) were defined for the current phase of the RDRR project:

- South West Rim Drive (South WRD)
- Central West Rim Drive (Central WRD)
- North West Rim Drive (North WRD)

- Northwest East Rim Drive (NW ERD)
- Northeast East Rim Drive (NE ERD)

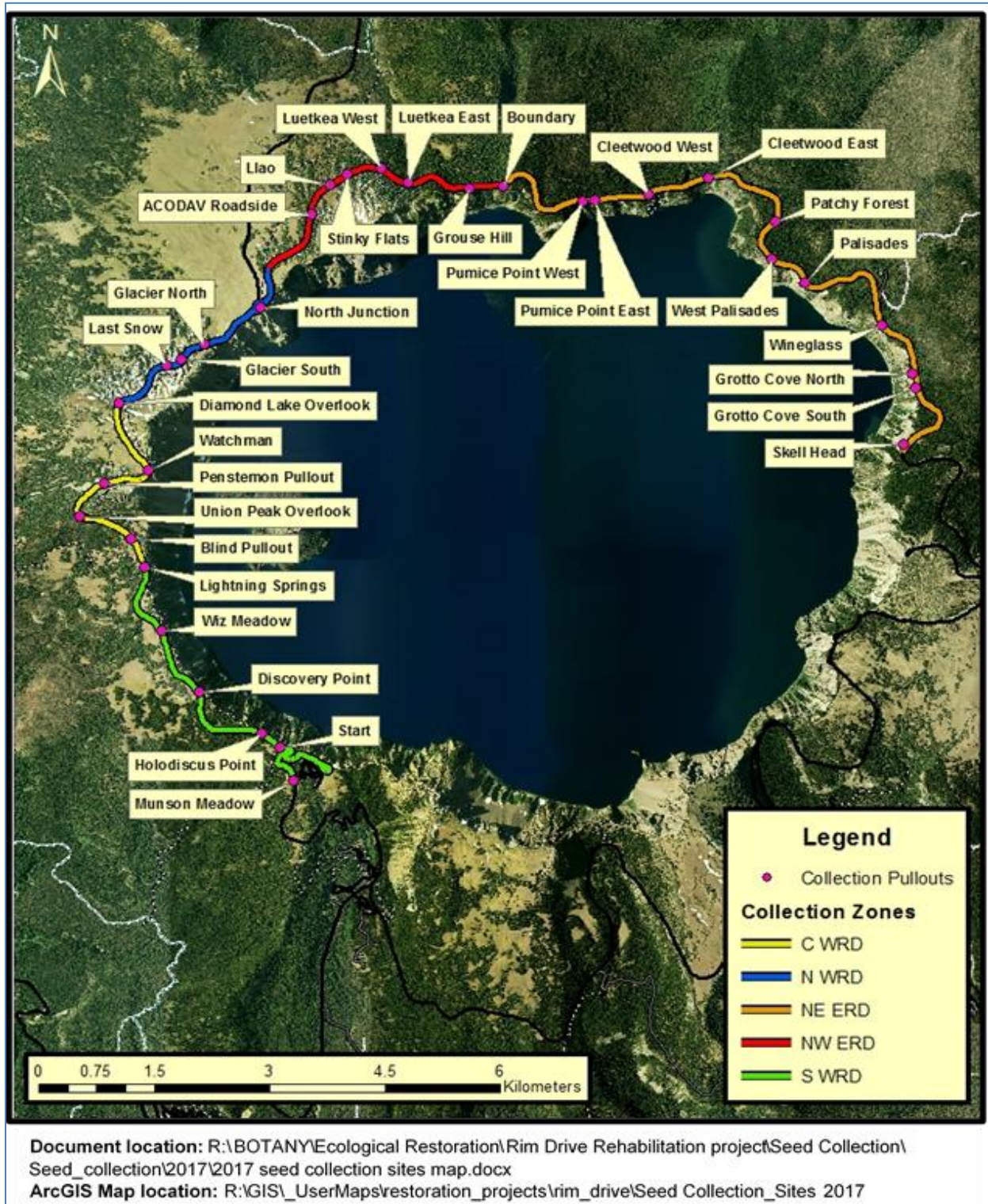


Figure 4. Seed collection zones with notable pullouts indicated. Map by Tara Chizinski.



Once seed zones were delineated, a discrete revegetation species list for the project was developed. In order to develop a cost-effective agreement and work plan between CRLA and the Corvallis Plant Material Center (PMC), it was determined that using eight to ten plant species (accessions) per seed zone would be adequate for revegetation efforts (Table 2).

**Table 2.** 2017 seed collection species list per seed collection zone.

<b>Zone</b>	<b>Scientific Name</b>	<b>Zone</b>	<b>Scientific Name</b>
<b>South WRD</b>	<i>Achnatherum occidentale</i>	<b>NW ERD</b>	<i>Achnatherum occidentale</i>
	<i>Anaphalis margaritacea</i>		<i>Aconogonon davisiae</i> var. <i>davisiae</i>
	<i>Bromus carinatus</i> var. <i>carinatus</i>		<i>Carex breweri</i>
	<i>Calyptridium umbellatum</i>		<i>Castilleja arachnoides</i>
	<i>Carex halliana</i>		<i>Elymus elymoides</i> ssp. <i>elymoides</i>
	<i>Carex pachycarpa</i>		<i>Eriogonum marifolium</i> var. <i>marifolium</i>
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>		<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>
	<i>Ericameria greenei</i>		<i>Juncus parryi</i>
	<i>Eriogonum marifolium</i> var. <i>marifolium</i>		<i>Luetkea pectinata</i>
	<i>Holodiscus microphyllus</i> var. <i>glabrescens</i>		<i>Lupinus lepidus</i> var. <i>lobbii</i>
	<i>Lupinus andersonii</i>		<i>Phacelia hastata</i> ssp. <i>compacta</i>
	<i>Phlox diffusa</i>		
<b>Central WRD</b>	<i>Achnatherum occidentale</i>	<b>North WRD</b>	<i>Achnatherum occidentale</i>
	<i>Aconogonon davisiae</i> var. <i>davisiae</i>		<i>Aconogonon davisiae</i> var. <i>davisiae</i>
	<i>Anaphalis margaritacea</i>		<i>Anaphalis margaritacea</i>
	<i>Anemone occidentalis</i>		<i>Anemone occidentalis</i>
	<i>Calyptridium umbellatum</i>		<i>Calyptridium umbellatum</i>
	<i>Castilleja applegatei</i>		<i>Carex breweri</i>
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>		<i>Elymus elymoides</i> ssp. <i>elymoides</i>
	<i>Ericameria greenei</i>		<i>Ericameria greenei</i>
	<i>Eriogonum marifolium</i> var. <i>marifolium</i>		<i>Eriogonum marifolium</i> var. <i>marifolium</i>
	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>		<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>
	<i>Juncus parryi</i>		<i>Lupinus andersonii</i>
	<i>Penstemon davidsonii</i> var. <i>davidsonii</i>		<i>Lupinus lepidus</i> var. <i>lobbii</i>
<i>Phacelia hastata</i> ssp. <i>compacta</i>	<i>Penstemon davidsonii</i> var. <i>davidsonii</i>		
<i>Phlox diffusa</i>	<i>Phlox diffusa</i>		
<b>NE ERD</b>	<i>Achnatherum occidentale</i>		<i>Ericameria nauseosa</i> var. <i>speciosa</i>
	<i>Bromus carinatus</i> var. <i>carinatus</i>		<i>Lupinus lepidus</i> var. <i>lobbii</i>
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>		<i>Phacelia hastata</i> ssp. <i>compacta</i>

The 2017 seed collection efforts added to seeds collected during the 2013-2016 seasons. The seed collection process commenced in 2017 by observing and documenting the phenology of each targeted species at each revegetation site within each seed zone. Notes were taken on plant phenology, seed maturity, and collection techniques; these observations helped refine seed collection protocols for each species (Beck et al. 2017). Maps were developed for all seed collection locations

for species in each seed zone; these are stored in Botany program files (R:\Botany\Ecological Restoration\Rim Drive Rehabilitation Project\Seed Collection\Seed Collection\2017\maps). Each seed zone has sites containing large populations of each species that crews collected from in 2017 (Appendix B).

The Corvallis PMC and DSC staffs recommended collecting large quantities of seed from abundantly occurring species, as custom seed mixes can be supplemented with excess seed that can also be available to accommodate unanticipated disturbance areas. Species substitutions and a couple of species additions were approved to help fill in any gaps in the species accession list.

To maximize plant materials collected during the 2016 and 2017 seasons, assistance from a contracted seed collection crew was obtained to collect from ‘workhorse’ species (those which were considered easy to identify, plentiful in their respective zones, producing copious amounts of seed per plant, and easily establishing via seed or plant plugs) to allow the CRLA Revegetation crew to focus on collecting seed from more difficult to collect from and/or less abundant species. The Institute for Applied Ecology (IAE) was assigned thirteen of the most readily available species: needlegrass (*Achnatherum occidentale*), Pearly everlasting (*Anaphalis margaritacea*), California brome (*Bromus carinatus* var. *carinatus*), Pussypaws (*Calyptridium umbellatum*), Oregon sedge (*Carex halliana*), common squirreltail (*Elymus elymoides* ssp. *elymoides*), Greene’s goldenweed (*Ericameria greenei*), showy rubber rabbitbrush (*Ericameria nauseosa* var. *speciosa*), yellow-flowered wild buckwheat (*Eriogonum marifolium* var. *marifolium*), alpine buckwheat (*Eriogonum pyrolifolium*), bush ocean spray (*Holodiscus microphyllus* var. *glabrescens*), Parry’s rush (*Juncus parryi*), and mountain phacelia (*Phacelia hastata* ssp. *compacta*). The IAE made five collection trips over the course of the 2017 season and reported their findings (Getty 2017b). The IAE sent the collected seed to the US Forest Service Bend Seed Extractory, and the cleaned seed will be stored at the Corvallis PMC.



**Figure 5.** Collecting seed near the Watchman Overlook. Photo by Carrie Wyler.

When seeds were mature, they were collected, dried, and stored until shipment to the Corvallis PMC. Within each zone a single bag was used to collect all the seed from an individual species (Figure 5). In the field, bags were labelled with species code, collection date, and seed zone. After collection, seeds were transported to the seed drying and storage facility in the Stall Nine garage at Park headquarters (Figure 6). When seeds arrived at this facility, records were kept for each species with collection dates, specific collection location, and seed zone. Seeds were then dumped inside 30-gallon plastic storage totes secured with window screen at the top, allowing ventilation while reducing chances of

predation. Plant species that spilled very small seeds were first placed in smaller plastic bins before being stored within the larger 30-gallon tubs. The bins were labelled and organized on shelves in a storage facility by seed zone and species. Damp collections (especially lupines) were either shipped soon after collection (within a week), or set out in the sun during the day to speed the drying process.

Prior to shipping seed to the Corvallis PMC, all seeds from a single species within a discrete seed zone were combined into doubled paper bags; each bag was labeled with species code and seed zone and taped shut. Records were kept of boxes shipped and their contents. Shipping seeds throughout the growing season was crucial due to the lack of seed storage space at the Park, and inadequate ventilation for effective drying of damp material.

Due to the large area in need of restoration, and the difficulty in collecting adequate amounts of seed each year, in 2016 CRLA staff began the process of establishing seed increase beds from which 100% of the seed could be collected. Two seed increase beds (2'x4'x16') were constructed and positioned in the South Yard, which is at a lower elevation providing the opportunity to maximize on solar radiation and growing season length (Figure 7). In 2017, caged lids were constructed and added to the beds in order to prevent predation. The seed beds were filled with soil and planted with species from the North West Rim Drive seed zone.



**Figure 6.** Seed drying and storage facility in the Stall Nine garage. Photo by Carrie Wyler.



**Figure 7.** Seed increase beds at the South Yard. Photo by Carrie Wyler.

### ***Plant Care and Nursery Work***

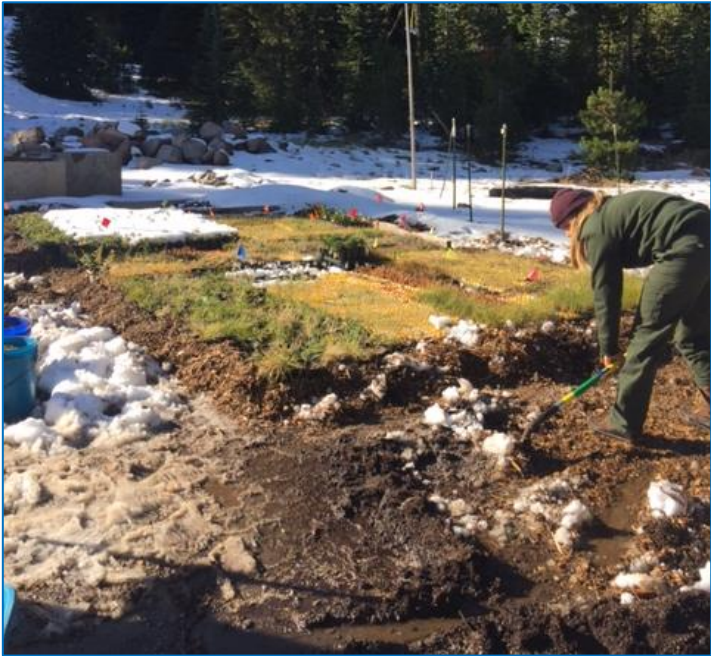
In 2016, 15,318 native plants were grown at the Corvallis PMC and delivered to the Park. Due to early and abundant snowfall in October of 2016, many plants were unable to be planted and approximately 10,000 plants were overwintered at the Ballfield near Park headquarters. These plants then required care and maintenance throughout the 2017 field season. Once the snow melted out in June, plants were covered with a shade house (40'x 20'x10' – Figure 8). The plants were fertilized as



**Figure 8.** Improvements to CRLA’s Revegetation program during the 2016/2017 season: expanded 2017 shadehouse (left); shadehouse used to hold over plants from 2016 (right). Photos by Carrie Wyler.

prescribed by the Corvallis PMC employees. Fertilization occurred approximately every 2 weeks at a rate of 1tsp/gallon. Descriptions of fertilization procedures can be found in Botany program files in the “Nursery Activities” binder. Excess growth was manually trimmed with scissors or hedge clippers as needed. Any reproductive structures were removed to promote root development and prevent excess evapotranspiration, and dead growth was removed to discourage fungal growth. Undesired plant volunteers originating from the Corvallis PMC in the planting tubes (e.g., moss, liverworts, and weeds) were removed before planting to minimize the risk of introducing non-native plant species to the Park.

As of November 2017, many of the scheduled pullout obliterations, parking area modifications, and creation of landscaping islands had not been completed; this necessitated holding over plants through another winter at the Ballfield. When the ambient temperature dropped below freezing the containers were consolidated and mulch was stacked around the bases of herbaceous plants to prevent root freezing (Figure 10). These plants will need further care in the summer of 2018 including watering, fertilization, and probable transplanting into larger containers.

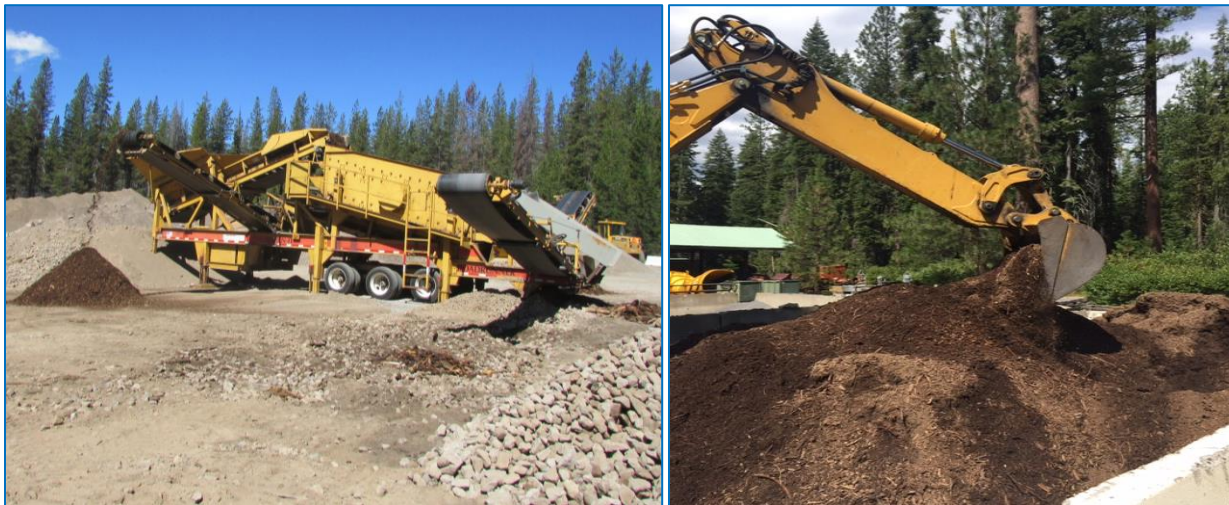


**Figure 10.** Plants being prepared for another overwintering period. Photo by Carrie Wyler.

### **Site Preparation**

Prior to planting or seeding a disturbed site, efforts are made to prepare the site for restoration. This entails ensuring the soil has been sufficiently decompacted, making certain the slope and appearance of the disturbed site blends in with the natural topography and appearance of the area, and smoothing out any vehicle tracks, berms, or other unnatural depressions at the site. Soils are amended with Park-sourced woody debris, compost, forest litter and duff, and/or naturally dehiscid herbaceous litter (e.g., tumbled Davis' knotweed – *Aconogonon davisiae* var. *davisiae* – stems that accumulate in roadside ditches) as appropriate. For example, forest debris would not be placed on a site to be restored back to a subalpine meadow; nor would meadow litter be placed on a forested site.

Beginning in 2016, Park-sourced mulch/compost and small coarse woody debris were acquired from Pole Bridge Creek Quarry for use in site preparation. With the aid of a large screen plant, partially composted woody debris was processed and sorted (Figure 11). Materials with particle size of < 5 cm were designated as compost and transported to the South Yard for further maturation and maintenance. Slightly larger materials (5 cm – 15 cm particle size), were retained and stored at the Ballfield adjacent to the shade house. Compost was routinely turned using heavy equipment for proper decomposition (Figure 11). The compost was, and will continue to be, used on restoration sites.



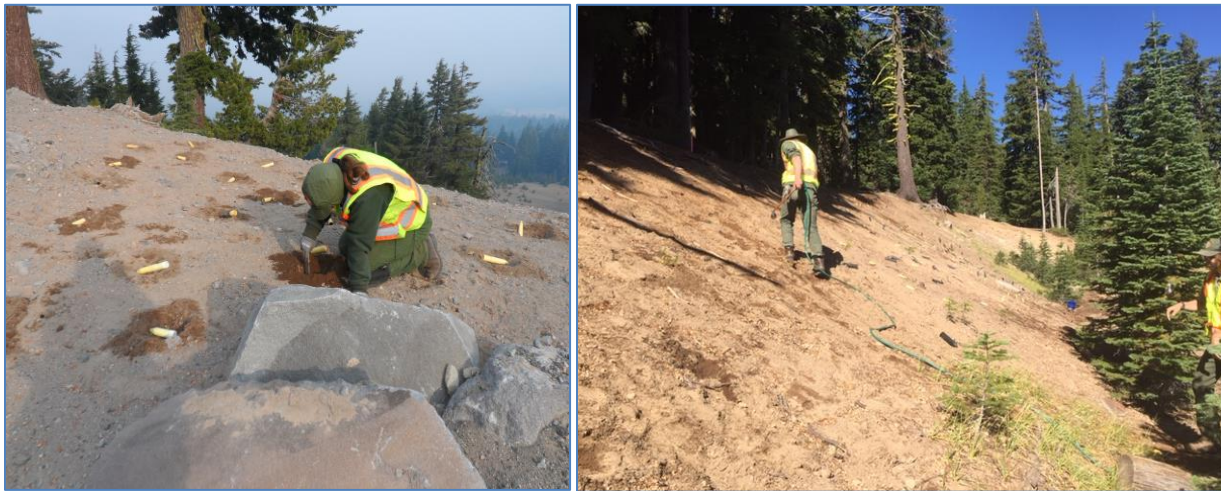
**Figure 11.** A screen plant was used to sort readily compostable materials (left) from partially composted woody debris to augment conditions at disturbed sites. Photo by Jen Hooke. Compost is routinely turned (right) to aid in decomposition. Photo by Carrie Wyler.

Compost temperature was monitored over the season and was found to be high enough to indicate active biota degrading the material. The compost was used to provide a source of natural fertilizer and mulch for newly planted seedlings. The compost also helped create local microclimates, retain soil moisture, and provide microfauna to help promote soil development and aid the establishment and growth of the seedlings. The woody materials were used to help stabilize recently disturbed and denuded sites from road construction while also helping create microclimates and seed pockets to further encourage the natural recovery of the areas. Larger woody debris (branches, logs, etc.) was

obtained from the surrounding forest at disturbed sites and added to restoration sites as appropriate to assist with erosion control and site amelioration.

### ***Planting and Seeding***

A mix of plant species was planted in the disturbance areas in accordance with the prescriptions and actual availability of plant materials. After planting, compost was added and plants were watered (Figure 13). Site-specific seed mixes were prepared and hand-broadcast over planted areas, and over areas with slopes that were too steep to plant. After broadcasting seeds, the sites were scarified with hand rakes and compost was broadcast over the scarified areas. The plants were watered from a truck mounted tank (Figure 13) until they were covered with snowfall.



**Figure 13.** Planting along the Watchman grade and adding compost to planting holes (left). Watering newly planted and mulched plants from a truck-mounted water tank (right). Photos by Carrie Wyler.

At restoration sites, holes were dug to a depth equal to or greater than the length of the planting tubes. Plants were carefully removed from the tubes by pressing on the sides of the tubes or tapping the rim of the tubes while they were inverted over the holes. After the plants had been removed, the roots were inspected for any signs of being root bound, having roots growing upward in the tube (“J”-rooting), or root girdling. If any of these were found, the roots were either trimmed or gently teased apart to encourage root growth and plant establishment. The plants were then placed in planting holes to ensure they were upright perpendicular to the pull of gravity (not relative to the local topography). Soil was then pushed back into the planting holes and tamped down gently to remove any air pockets in the soil. Plantings were installed so that the root collars of the plants were just at or slightly below the surface of the soil. Remaining soil or additional soil from the surrounding area was used to create a berm wall around the plants to facilitate water retention and help stabilize and protect plants. One or two handfuls of compost were then placed in the center of the rings around plants. After mulching, the plants were all watered at least once. A 200 gallon water tank was mounted in the bed of a truck on a wooden pallet and used in conjunction with an electric pump to facilitate watering of newly planted plugs.

### **Site Documentation and Monitoring**

The restoration process for each site was documented using monitoring forms and photo points. Photo points were established during the development of site prescriptions and were repeated prior to planting and just after planting. Photo points will continue to be taken once a year following revegetation efforts in order to monitor the status of vegetation recovery. The number and species of plants outplanted, the weights and species of seed broadcasted, and any natural litter/woody debris that was placed at the site were recorded on monitoring forms. The success of the restoration efforts will be monitored on a yearly basis through the completion of annual ocular assessments to determine the survival of planted species, the degree of vegetation establishment, and any additional needs for the site. Files are maintained for each restoration site that contains the site prescription, photo points, and monitoring forms. These files are located on the Botany program drive (R:\BOTANY\Ecological Restoration\Rim Drive Rehabilitation project\Revegetation\Site documentation).

### **Special Status Plant Management**

In the process of rehabilitating Rim Drive and implementing the Rockfall Mitigation project, many special status plant populations growing adjacent to Rim Drive have been or will be impacted. This includes populations of rare plants such as Mt. Shasta arnica (*Arnica viscosa*), pumice grapefern (*Botrychium pumicola*), Crater Lake rockcress, and shaggy hawkweed (*Hieracium horridum*). Whitebark pine (*Pinus albicaulis*), a candidate species for listing as threatened or endangered under the federal Endangered Species Act, is widespread throughout the project area. The world's largest known population of the Crater Lake rockcress along the Watchman grade was displaced by this project. In 2018, another population of Crater Lake rockcress will be disturbed at the Skell Head Overlook (Figure 14). To mitigate impacts to the Park's special status plant species, the RDRR program is charged with collecting baseline information on pre-disturbance special status plant populations; collecting seed from rare plants for propagation and revegetation; protecting whitebark pine from construction impacts; salvaging rare plants and caring for and monitoring them at a holdover facility; transplanting salvaged plants back into their habitat post-disturbance; conducting supplemental planting of propagated rare plants; and monitoring reestablished populations to inform management.



**Figure 14.** *Boechea horizontalis* at Skell Head Overlook. Photo by Melody Frederic.

## Invasive Vegetation Management

Crater Lake National Park has assigned all of its 86 non-native plant species a management priority of Low, Medium, High, or Watch. All high priority species are actively targeted for control efforts; medium priority species are targeted as time and resources allow. Low priority species are usually not targeted for management, either because populations of these species are not aggressively spreading or populations are beyond control. Watch species are those that have been documented within the Park, but have not been observed in some time (> 10 years) and are believed to be eradicated from within Park boundaries. If any watch species are found within the Park, they receive a management priority of high. These priorities may change depending upon situation and location. For example, most of the Rim Drive environment is relatively pristine and lacking non-native members. In this case, medium or low priority species may be treated in this area to protect the integrity of the vegetation communities adjacent to Rim Drive. Additionally, many rare plant species are found immediately adjacent to or nearby Rim Drive; low priority species may be controlled if they threaten rare plant populations.

The control strategies for invasive plants found within the RDRR project area are containment (preventing new infestations and spread); reduction (reducing the size and extent of existing infestations); and eradication (extirpating the invasive species from the Park). Since Rim Drive contains relatively few invasive plants, invasive plant populations along Rim Drive and project staging areas often have reduction or eradication strategies. The strategy at Rim Village is containment, reduction, or eradication as this location has a persistent invasive plant problem.

In 2017, the majority of the project area was surveyed for non-native, invasive plant species. Roadsides were surveyed multiple times throughout the season by foot as dictated by access (portions of West Rim Drive were difficult to access due to active construction and fire closures). Project staging areas (Roundtop Quarry, the Ballfield, Pole Bridge Creek Quarry, and the junction of East Rim Drive and Pinnacles Road) were surveyed at least two times by foot in their entirety, including access roads and around piles of materials.

When invasive plants are encountered, data are recorded including scientific name, UTM coordinates (Zone 10, NAD83 datum), total number of plants present, area occupied by invasive plants, and treatment applied to population. Invasive plants are controlled via manual (Figure 15) or chemical methods as per the Park's Invasive Vegetation Management Plan Environmental Assessment



**Figure 15.** Controlling invasive plants near the Crater Lake Lodge. Photo by Carrie Wyler.



(DOI NPS 2017). All plant parts capable of reproduction are bagged and disposed of in the trash compactor at Park headquarters. Vegetative parts incapable of reproduction are left to desiccate on site unless they present logistical or aesthetic problems for Park visitors, employees, and partners.

Any new-to-CRLA non-native plant species encountered are collected as voucher specimens for the Park's herbarium. Additionally, non-native plants encountered in previously undocumented locations are collected for the Park's herbarium.

## Results

Results are presented separately for each component of the RDRR project.

### Revegetation

#### **Site Prescriptions**

The 2013-2017 RDRR crews continued to develop prescriptions and make adjustments as unanticipated resource disturbance necessitated the addition of new restoration sites. Because the pre-disturbance vegetation community for these sites is typically destroyed and unavailable for use as a reference, revegetation prescriptions were developed from adjacent areas. As of November 2017, 56 restoration sites have been designated, each with a unique revegetation prescription. Documentation of these prescriptions can be found in Botany program files (R:\BOTANY\Ecological Restoration\Rim Drive Rehabilitation project\Revegetation\Site documentation).

#### **Seed Collection**

Fifty-seven seed accessions were collected, dried, and processed in 2017. Plant phenology was monitored during the season through biweekly visits to collection sites, and then later in the season by seed collection data sheets. Plant phenology in 2017 progressed later this season due to a high and persistent snow pack in the Park. Initial 2016 seed collection began in mid-July for a handful of plant species at sites with lower elevations and/or southern aspects and continued through early October. While in 2017, seed collection began in mid-August and continued through the end of October. The peak seed collection for the bulk of plant species in most of the zones occurred from mid-August to early October (Table 3). Some plant species offered a long collection period due to multiple flowering episodes throughout the growing season.

Five new species were added to the CRLA collection list for 2017: Howell's flatseed rockcress (*Boechera howellii*), dwarf monkeyflower (*Diplacus nanus*), Crater Lake sandwort (*Eremogone pumicola*), blue wildrye (*Elymus glaucus* ssp. *glaucus*) and cascade aster (*Eucephalus ledophyllus*). The CRLA Revegetation crew collected seeds from only certain species in 2017 (Table 4) due to the seed collection contract with the IAE and concerns that the IAE would not meet their targets if Park staff made overlapping seed collection efforts.



**Table 4.** Rim Drive Rehabilitation Revegetation project 2017 collection species listed by seed zones.

Common Name	Scientific Name	South WRD	Central WRD	North WRD	NW ERD	NE ERD
Needlegrass	<i>Achnatherum occidentale</i>	S	S	S	S	S
Davis' knotweed	<i>Aconogonon davisiae</i> var. <i>davisiae</i>		S	S	S	
Pearly everlasting	<i>Anaphalis margaritacea</i>	S	S	S		
Western pasqueflower	<i>Anemone occidentalis</i>		S			
Mt. Shasta arnica	<i>Arnica viscosa</i>			S		
Howell's flatseed rockcress	<i>Boechera howellii</i>	S			S	
California brome	<i>Bromus carinatus</i> var. <i>carinatus</i>	S				S
Pussy paws	<i>Calyptidium umbellatum</i>	S	S	S	S	S
Brewer's sedge	<i>Carex breweri</i>		S	S	S	
Hall's sedge	<i>Carex halliana</i>	S				S
Many-ribbed sedge	<i>Carex pachycarpa</i>	S			S	
Applegate's paintbrush	<i>Castilleja applegatei</i>	S	S	S	S	
Cobwebby paintbrush	<i>Castilleja arachnoides</i>	S	S	S	S	
Dwarf purple monkeyflower	<i>Diplacus nanus</i>					S
Squirreltail	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	S	S	S	S	S
Blue wildrye	<i>Elymus glaucus</i> ssp. <i>glaucus</i>	S				
Crater Lake sandwort	<i>Eremogone pumicola</i>	S			S	
Greene's goldenweed	<i>Ericameria greenei</i>	S	S	S		
Showy rubber rabbitbrush	<i>Ericameria nauseosa</i> var. <i>speciosa</i>					S
Sierra eriogonum	<i>Eriogonum marifolium</i> var. <i>marifolium</i>	S	S	S	S	
Alpine buckwheat	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	S	S	S	S	
Bush ocean spray	<i>Holodiscus microphyllus</i> var. <i>glabrescens</i>	S				
Cascade aster	<i>Eucephalus ledophyllus</i>	S				
Parry's rush	<i>Juncus parryi</i>	S			S	S
Partridgefoot	<i>Leutkea pectinata</i>				S	
Anderson's lupine	<i>Lupinus andersonii</i>	S		S		
Prostrate lupine	<i>Lupinus lepidus</i> var. <i>lobbii</i>			S	S	S
Davidson's penstemon	<i>Penstemon davidsonii</i> var. <i>davidsonii</i>		S	S		
Compact phacelia	<i>Phacelia hastata</i> ssp. <i>compacta</i>				S	S
Spreading phlox	<i>Phlox diffusa</i>	S	S	S		

S = seed collection occurred.

= Species IAE collected

= Species Crater Lake collected

Overall, seed collection efforts were heightened in 2016 and 2017 due to assistance from the IAE. With the IAE's focus on collecting seed from workhorse species, the CRLA Revegetation staff collected greater quantities of seed from more challenging plant taxa including Anderson's lupine, Hall's sedge, Applegate's paintbrush, cobwebby paintbrush, Howell's flatseed rockcress, dwarf monkeyflower, Crater Lake sandwort, Cascade aster, spreading phlox, and Davis' knotweed. Deer and insect predation pose a major threat to developing Anderson's lupine seed, while predation from unknown insects significantly reduces seed viability for Hall's sedge, cobwebby paintbrush, and Applegate's paintbrush. Low mountain lupine did not produce many seed pods in 2017 compared to previous years, and thus resulted in lower viable amounts of seed. Davis' knotweed continued to pose a challenge to seed collection and plant propagation efforts. Fertilization appears to be very patchy in the field, and while fruit development can be detected for the first few months after fertilization, many developing seeds appear to be aborted weeks before any viable seed can be acquired. Previous



**Figure 16.** The almost woody root system of Davis' knotweed.  
Photo by Jen Hooke.

attempts at propagating Davis' knotweed (Figure 16) suggest root division/cuttings are viable means of propagating Davis' knotweed (Trindle and Fessner 2003); however, initial tests of this method by the Corvallis PMC were largely unsuccessful.

Results of the 2017 seed collection effort by the IAE are summarized in a final report (Getty and Currin 2018). Due to many factors, some of the IAE's target seed weights were not achieved during the 2016/2017 season (Table 5). Some of these

factors include inclement weather during scheduled seed collection trips; poor air quality from Park fires preventing scheduled field work from being completed; and early snowfall (Getty and Currin 2018). To account for the shortfalls, many of the deficiencies in 2016 were rolled over into 2017 targets for seed weights. In situations where the seed was not available on the landscape for rollover, substitute species were identified with target seed weights for 2017:

- *Calyptidium umbellatum*: 0.4 lbs
- *Anaphalis margaritacea*: 0.5 lbs
- *Juncus parryi*: 2.0 lbs
- *Phacelia hastata* ssp. *compacta*: 0.5 lbs

**Table 5.** Results from the 2017 IAE seed collection effort.

Plant Species	2016 PLS* (lbs)	2016 Target PLS (lbs)	Adjusted 2017 Target PLS (lbs)	2017 PLS (lbs)	2017 Comments
<i>Achnatherum occidentale</i>	1.79	5.0	9.00	9.12	Final target is same as original contract
<i>Bromus carinatus</i> var. <i>carinatus</i>	5.65	5.0	10.50	8.59	Final target is same as original contract
<i>Carex halliana</i>	2.69	3.0	1.00	7.75	Final target is same as original contract
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	6.85	10.0	9.50	9.55	Final target is same as original contract
<i>Eriogonum</i> sp. **	1.67 <sup>1</sup> 0.36 <sup>2</sup>	4.0	5.97	8.81	Final target is same as original contract
<i>Ericameria greenei</i>	0	1.5	0.50	0.79	Quantity revised downward. Quantity carried over in substitute species.
<i>Ericameria nauseosa</i> var. <i>speciosa</i>	0	1.5	0.50	0.90	Quantity revised downward. Quantity carried over in substitute species.
<i>Holodiscus microphyllus</i> var. <i>glabrescens</i>	0.11	1.5	0.75	0.001	Quantity revised downward. Quantity carried over in substitute species.
<i>Anaphalis margaritacea</i>	--	--	0.5	0.001	2017 Substitute species
<i>Calyptidium umbellatum</i>	--	--	0.4	0.024	2017 Substitute species
<i>Juncus parryi</i>	--	--	2.0	0.023	2017 Substitute species
<i>Phacelia hastata</i> ssp. <i>compacta</i>	--	--	0.5	0.045	2017 Substitute species

\* PLS = pure live seed.

\*\*Target PLS weight was combined for *Eriogonum* sp. to a total of 5.97 lbs PLS for both species.

In 2016 the IAE analyzed cleaned seed for viability and purity at the Oregon State University Seed Laboratory. Results of testing detected small amounts of weed seed in the total PLS weight for some species (Getty 2017a). Since preventing the establishment of non-native plants is paramount to this project's success, re-cleaning of seed collected by the IAE was performed by the US Forest Service Bend Seed Extractory in 2017. Seed collected by the IAE in 2016 was re-cleaned by the Bend Seed Extractory prior to its application within the Park.

After deep patch operations along East Rim Drive ceased in 2015, a much larger disturbance footprint was realized than initially anticipated (Figure 17). To mitigate for the increased levels of disturbance, it was agreed to use the seed increase services of the Meeker PMC to increase the abundance of plant materials available for restoration. In fall of 2015, 714 g of California brome and 2,218 g of squirreltail seed were sent to the Meeker PMC for seed increase. The seeds produced at the Meeker PMC will be collected, cleaned, and shipped to the Park in the fall of 2018 and 2019 for use in broadcast seed application for restoration. To maximize seed yield, it was agreed to combine squirreltail seeds from all seed zones for seed increase purposes. California brome seeds were combined from the three West Rim Drive seed zones, and also from the two East Rim Drive seed zones. Expected production totals from the Meeker PMC are displayed in Table 6.



**Figure 17.** Deep patch operations along East Rim Drive created unanticipated disturbance of areas including this slope. Photo by Carrie Wyler.

**Table 6.** Expected production totals from seed increase efforts by the Meeker PMC.

Plant Species and Seed Zone	2018 PLS (lbs)	2019 PLS (lbs)
California brome – West Rim Drive zones	40	40
California brome – East Rim Drive zones	40	40
Squirreltail – all zones	75	75

PLS = pure live seed.

### ***Plant Care and Nursery Work***

In 2016, over 15,000 native plants were grown at the Corvallis PMC and delivered to the Park. Due to early and abundant snowfall in October of 2016 and delays in the construction schedule, approximately 10,000 of these plants were unable to be planted and were overwintered at the Ballfield near park headquarters (Figure 18). These plants were then cared for by the Botany crew throughout the 2017 field season. When the majority of the plants had melted out in June, plants

without any green growth or with rotted roots were discarded. Certain species experienced substantially higher survivorship than others, with grasses, sedges and rushes having the greatest success, and species such as *Eriogonum marifolium* var. *marifolium*, *Penstemon davidsonii* var. *davidsonii*, *Lupinus lepidus* var. *lobbii*, *Ericameria greenei*, *Ericameria nauseosa* var. *speciosa*, and *Luetkea pectinata* experiencing high mortality. In order to make up for the loss of these species, approximately 1,500 of the grasses and rushes were divided (Figure 18). Among the divided plants there was an estimated 75% survival rate. These divisions helped to partially recoup the losses experienced from overwintering. Detailed reports of daily nursery activities and plant care are in Botany program files in the Nursery Activities binder.



**Figure 18.** Overwintered plants melting out in June 2017 (left). Dividing plants at the South Yard (right). Photos by Carrie Wyler.

### **Site Preparation**

Due to very few of the disturbance areas being ready for restoration this season, there was very little site preparation that occurred in 2017. Two of the pullouts on West Rim Drive that were insufficiently obliterated in 2016 had still not been corrected (Figure 19). Other areas (e.g., Watchman Overlook, Cleetwood Cove Parking Lot) were not finished to the point of being able to prepare sites for restoration. The sites that were available for restoration were prepared prior to planting and/or seeding as per established methods.



**Figure 19.** An obliterated pullout with insufficient site preparation, as the restored area looks more like a “worm” of placed topsoil rather than a natural landscape feature (left). Obliterated pullouts were inspected for signs of soil compaction (right). Photos by Ken Stella.

***Planting and Seeding***

The Revegetation crew had planned to restore scheduled disturbance areas along West and East Rim Drives in the fall of 2017. Road construction plans for the 2017 season included finishing all obliterated pullouts along East and West Rim Drives. Accordingly, Park staff worked with the DSC Revegetation Specialists and the Corvallis PMC to have adequate plant materials (plants and seed) available for revegetation. The contractor assigned to the Rim Drive Rehabilitation project fell behind schedule, and as a result the only areas ready for restoration included unanticipated disturbance areas and two obliterated pullouts along West Rim Drive, one of which lacked adequate site preparation; and four small islands and an unplanned disturbed embankment at the Cleetwood Cove parking lot on East Rim Drive. A few early snow storms that hit in September and October (Figure 20) further compounded an already delayed construction schedule and resulted in not being able to revegetate areas that were scheduled for restoration.



**Figure 20.** Early abundant snowfall in October 2017 shortened the restoration window. Photo by Carrie Wyler.

Prior to revegetation efforts commencing in the fall of 2017, the Corvallis PMC delivered 46.4 lbs. of cleaned seed collected from CRLA native plants,



and IAE delivered 17.5 lbs. of rough cleaned seed. Despite having few areas that were planned for restoration available due to delays in the contractor's work schedule, the CRLA Revegetation crew was able to use plant materials to restore areas that experienced unplanned disturbance. Additionally, seed and plants were added to sites that had been previously restored but were assessed as having poor recovery. In total, nine sites received initial or supplemental planting and seeding. The amount of seed and number of plants that each site received are summarized in Table 7. The status of restoration completion as of November 2017 is displayed in Table 8.

**Table 7.** Restoration planting and seeding totals for the 2017 field season.

Zone	Restoration Site	Plant Species	Number Planted	Grams of Seed Dispersed
Central WRD	CWRD4.01	<i>Achnatherum occidentale</i>	1	12
		<i>Anemone occidentalis</i>		200
		<i>Boechera horizontalis</i>	99	
		<i>Castilleja applegatei</i>		10
		<i>Elymus elymoides</i> ssp. <i>elymoides</i>	10	
		<i>Ericameria greenei</i>		10 (unclean)
		<i>Eriogonum marifolium</i> var. <i>marifolium</i>	27	35
		<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	19	
		<i>Penstemon davidsonii</i> var. <i>davidsonii</i>		25
			<i>Phlox diffusa</i>	18
	CWRD4.1	<i>Achnatherum occidentale</i>	15	
		<i>Aconogonon davisiae</i> var. <i>davisiae</i>	34	
		<i>Anemone occidentalis</i>		500
		<i>Castilleja applegatei</i>		10
		<i>Elymus elymoides</i> ssp. <i>elymoides</i>	26	
		<i>Ericameria greenei</i>		30 (unclean)
		<i>Eriogonum marifolium</i> var. <i>marifolium</i>		50
		<i>Penstemon davidsonii</i> var. <i>davidsonii</i>		50
	<i>Phlox diffusa</i>	27		
	CWRD4.2	<i>Achnatherum occidentale</i>	9	
		<i>Aconogonon davisiae</i> var. <i>davisiae</i>	8	
		<i>Anemone occidentalis</i>		150
		<i>Boechera horizontalis</i>	10	
		<i>Castilleja applegatei</i>		5
		<i>Elymus elymoides</i> ssp. <i>elymoides</i>	4	
		<i>Ericameria greenei</i>	22	20 (unclean)
		<i>Eriogonum marifolium</i> var. <i>marifolium</i>	7	50
		<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	4	
		<i>Penstemon davidsonii</i> var. <i>davidsonii</i>		20
	<i>Phlox diffusa</i>	6		
	CWRD8	<i>Achnatherum occidentale</i>	25	5
		<i>Aconogonon davisiae</i> var. <i>davisiae</i>	28	2

Zone	Restoration Site	Plant Species	Number Planted	Grams of Seed Dispersed
		<i>Anemone occidentalis</i>		150
		<i>Elymus elymoides</i> ssp. <i>elymoides</i>	23	5
		<i>Ericameria greenei</i>	18	40 (unclean)
		<i>Eriogonum marifolium</i> var. <i>marifolium</i>	10	20
		<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	32	
		<i>Penstemon davidsonii</i> var. <i>davidsonii</i>		10
		<i>Phlox diffusa</i>	20	
North WRD	NWRD2	<i>Aconogonon davisiae</i> var. <i>davisiae</i>	68	5
		<i>Carex breweri</i>	14	
		<i>Elymus elymoides</i> ssp. <i>elymoides</i>	98	65
		<i>Ericameria greenei</i>		12 (7g unclean)
		<i>Eriogonum marifolium</i> var. <i>marifolium</i>	57	25
		<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	97	
		<i>Lupinus lepidus</i> var. <i>lobbii</i>		50
		<i>Penstemon davidsonii</i> var. <i>davidsonii</i>	10	30
Northeast ERD	NEERD1	<i>Lupinus lepidus</i> var. <i>lobbii</i>		16
		<i>Phacelia hastata</i> ssp. <i>compacta</i>		10
	NEERD3	<i>Arctostaphylos nevadensis</i>	4	
		<i>Arctostaphylos patula</i>	9	
		<i>Bromus carinatus</i> var. <i>carinatus</i>	20	
		<i>Carex halliana</i>		20
		<i>Elymus elymoides</i> ssp. <i>elymoides</i>	12	
		<i>Lupinus lepidus</i> var. <i>lobbii</i>		10
	NEERD3.1	<i>Achnatherum occidentale</i>		18
		<i>Arctostaphylos nevadensis</i>	92	
		<i>Arctostaphylos patula</i>	30	
		<i>Bromus carinatus</i> var. <i>carinatus</i>	88	
		<i>Carex halliana</i>		232
		<i>Elymus elymoides</i> ssp. <i>elymoides</i>	90	
		<i>Ericameria nauseosa</i> var. <i>speciosa</i>	18	65 (50g unclean)
		<i>Phacelia hastata</i> ssp. <i>compacta</i>		35
	NEERD15	<i>Achnatherum occidentale</i>		18
		<i>Boechera horizontalis</i>		0.3
		<i>Lupinus lepidus</i> var. <i>lobbii</i>		10
		<i>Phacelia hastata</i> ssp. <i>compacta</i>		6
<b>TOTAL</b>			<b>1,209</b>	<b>2,036.30</b>

**Table 8.** Restoration completion status as of fall 2017.

Seed Zone	# Sites Restored	Total # Sites to be Restored	Fall 2017 Completion (%)
South WRD	0	6	0.0
Central WRD	5	11	45
North WRD	1	6	16.7
NW ERD	8	16	50.0
NE ERD	11	17	64.7
<b>Total</b>	<b>25</b>	<b>56</b>	<b>44.6</b>

In 2017, 8,036 plants were not able to be planted and will be overwintered at the Ballfield (Table 9). Plants with less-than-optimal root development were planted first in seed zones where planting was possible. Plants exhibiting better root development and overall good health were selected for overwintering, with hopes of transplanting them into larger containers the following spring and planting them next fall. The overwintered plants were covered with two feet of snow during the last weeks of September (Figure 21), but were snow-free again after warm, dry weather in early October. They were finally covered with a persistent snowpack in early November.

**Table 9.** Native plants and seed delivered to the Park in 2016, along with remaining quantities in 2017.

Plant Species	2016 Plant Delivery (#)	2017 Plants Remaining (#)	2016 Seed Delivery (g)	2017 Seed Collection by Park staff (g)	2017 Seed in Storage (g)
<b>South West Rim Drive Seed Zone</b>					
<i>Achnatherum occidentale</i>	0	0	0	0	364
<i>Bromus carinatus</i> var. <i>carinatus</i>	0	0	0	0	1,863
<i>Carex halliana</i>	0	0	0	0	1,169
<i>Carex pachycarpa</i>	0	0	0	575	2,583
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	0	0	0	0	649
<i>Ericameria greenei</i>	0	0	0	94	124
<i>Eriogonum marifolium</i> var. <i>marifolium</i>	0	0	0	0	1,091
<i>Holodiscus microphyllus</i> var. <i>glabrescens</i>	0	0	0	64	136
<i>Lupinus andersonii</i>	0	0	0	682	1,665
<i>Phlox diffusa</i>	0	0	0	7	19
<b>Central West Rim Drive Seed Zone</b>					
<i>Achnatherum occidentale</i>	370	174	0	0	157
<i>Aconogonon davisiae</i> var. <i>davisiae</i>	190	98	0	6.3	58
<i>Anemone occidentalis</i>	0	0	390	1,632	3,727
<i>Boechera horizontalis</i>	950	411	0	0	7.5
<i>Carex breweri</i>	0	0	0	8.1	8
<i>Castilleja applegatei</i>	0	0	0	24	19
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	900	252	90	0	59

Plant Species	2016 Plant Delivery (#)	2017 Plants Remaining (#)	2016 Seed Delivery (g)	2017 Seed Collection by Park staff (g)	2017 Seed in Storage (g)
<i>Ericameria greenei</i>	0	0	124	32	128
<i>Eriogonum marifolium</i> var. <i>marifolium</i>	500	25	730	0	548
<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	285	27	48	0	33
<i>Penstemon davidsonii</i> var. <i>davidsonii</i>	220	0	101	73.2	211
<i>Phlox diffusa</i>	290	232	0	11	28
<b>North West Rim Drive Seed Zone</b>					
<i>Achnatherum occidentale</i>	0	0	0	0	78
<i>Aconogonon davisiae</i> var. <i>davisiae</i>	300	167	0	20	47
<i>Arnica viscosa</i>	0	0	0	0	0.2
<i>Carex breweri</i>	1,000	807	0	88.5	315
<i>Castilleja arachnoidea</i>	0	0	0	2.5	2.5
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	1,500	636	0	0	960
<i>Ericameria greenei</i>	0	0	0	16	70
<i>Eriogonum marifolium</i> var. <i>marifolium</i>	130	19	0	0	370
<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	828	460	0	0	41
<i>Lupinus andersonii</i>	0	0	0	22.6	277
<i>Lupinus lepidus</i> var. <i>lobbii</i>	0	0	0	37	301
<i>Penstemon davidsonii</i> var. <i>davidsonii</i>	300	148	0	3.6	128
<i>Phlox diffusa</i>	0	0	0	6.3	28
<b>Northwest East Rim Drive Seed Zone</b>					
<i>Achnatherum occidentale</i>	300	87	0	0	0
<i>Aconogonon davisiae</i> var. <i>davisiae</i>	150	37	49	61.5	93
<i>Carex breweri</i>	0	0	152	10	53
<i>Castilleja arachnoidea</i>	50	0	0	16.7	16.7
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	1,200	851	911	0	0
<i>Eriogonum marifolium</i> var. <i>marifolium</i>	0	0	98	0	40
<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	0	0	153	0	99
<i>Juncus parryi</i>	225	148	200	3	191
<i>Luetkea pectinata</i>	300	96	211	13	222
<i>Lupinus lepidus</i> var. <i>lobbii</i>	100	1	219	13.4	12.7
<b>Northeast East Rim Drive Seed Zone</b>					
<i>Achnatherum occidentale</i>	370	58	320	0	0
<i>Boechera horizontalis</i>	0	0	0	0	0
<i>Bromus carinatus</i> var. <i>carinatus</i>	900	784	0	0	0
<i>Carex halliana</i>	0	0	126	0	0
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	1,100	633	0	0	0
<i>Ericameria nauseosa</i> var. <i>speciosa</i>	300	99	0	0	39

Plant Species	2016 Plant Delivery (#)	2017 Plants Remaining (#)	2016 Seed Delivery (g)	2017 Seed Collection by Park staff (g)	2017 Seed in Storage (g)
<i>Lupinus lepidus</i> var. <i>lobbii</i>	200	0	46	31.5	15
<i>Phacelia hastata</i> ssp. <i>compacta</i>	280	0	101	0	37
<i>Arctostaphylos nevadensis</i>	1573	394	0	0	0
<i>Arctostaphylos patula</i>	545	101	0	0	0



**Figure 21.** Plants covered by an early October 2017 snow storm. Photo by Carrie Wyler.

Due to the fact that a majority of the plants delivered in 2016 were still not able to be planted along Rim Drive, some plants were temporarily planted in the Park’s seed increase beds at the South Yard (Figure 22). Some plant species did not overwinter well in pots over the 2016/2017 winter. For that reason, three plant species were chosen to be planted in the seed increase beds based on difficulty of collecting their seed in the field and their chances of surviving the winter. The three plant species were *Eriogonum marifolium* var. *marifolium*, *Eriogonum pyrolifolium* var. *coryphaeum*, and *Penstemon davidsonii* var. *davidsonii* (Table 10).



**Figure 22.** Planting seed increase beds at the Park’s South Yard with plants from Rim Drive (left). The seed increase bed on the right shows its caging lid to protect from animal predation. Photos by Tara Chizinski.

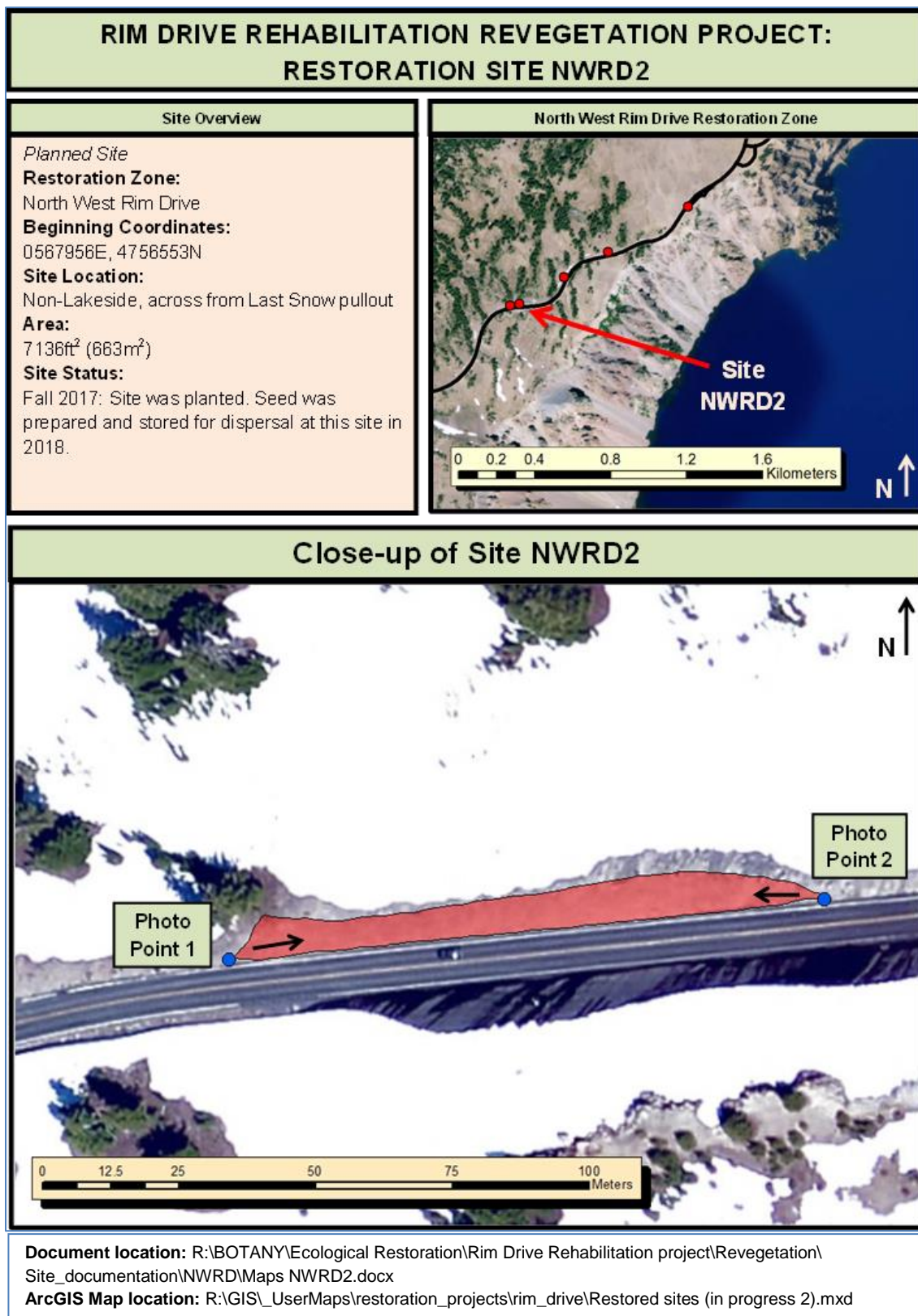
**Table 10.** Species and quantities of RDRR plants that were planted in the Park’s seed increase beds in 2017.

Plant Species	Seed Zone	Bed #	Quantity
<i>Eriogonum marifolium</i> var. <i>marifolium</i>	North WRD	2	16
<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	North WRD	1	144
<i>Penstemon davidsonii</i> var. <i>davidsonii</i>	North WRD	2	71

**Site Documentation and Monitoring**

Site documentation, mapping, and monitoring were completed for all sites that were restored in 2016 and 2017. For sites restored in 2016, new photo points were taken and one year post-restoration monitoring forms were completed as a means of assessing the success of revegetation efforts and determining additional site needs. The success of 2016 planting and seeding was variable, with some sites having high survivorship of plantings and significant regeneration, while other sites still had very low overall vegetation cover. Some sites needed additional seeding and/or planting to supplement the 2016 work. However, most sites were assessed as having moderate or good regeneration and were left as-is; they will be reassessed next year. For sites restored in 2017, photo points were taken and documentation forms completed to record the number of plants and grams of seed that were placed at each site.

Additionally, overview documents (Figure 23) were created for each restoration site, including a map of the site, description of the site location, and location of photo points. These documents show the precise area and location of the sites and can be used in combination with the monitoring forms as a way of tracking restoration progress from year to year at each specific site. Binders for each zone were created that contain site maps and all monitoring documentation for each restoration site.



**Figure 23.** Example of a site overview map that was created in order to aid in site documentation and assist future staff in precisely locating and monitoring restoration sites. Created by Tara Chizinski.

These binders are on file in the Botany office and available for reference by future staff. Overview maps and complete site documentation forms for all sites can be found in Botany program files (R:\BOTANY\Ecological Restoration\Rim Drive Rehabilitation project\Revegetation\Site documentation).

### Special Status Plant Management

During the 2017 season, 357 salvaged Crater Lake rockcress plants were replanted along the Watchman grade. Additionally, 75 pots with numerous Crater Lake rockcress plants were salvaged from the Skell Head Overlook wall and sidewalk (Figure 24). The wall is slated to be rebuilt and reinforced, and this construction will impact the plants growing in and near the wall. Salvaged plants were watered and cared for on a weekly basis at the Ballfield shade house. Salvaged plants were monitored in 2017 on 7/11, 8/9, and 9/27 for health, phenology, and survival.



**Figure 24.** Salvaging *Boechea horizontalis* at Skell Head overlook (left). Crater Lake rockcress plants salvaged from the Skell Head overlook (right). Photos by Carrie Wyler.

The entirety of the East Rim Drive was surveyed for rare plants in 2017. Approximately 1,350 Mt. Shasta arnica plants were found within the road prism. Also, 1,698 shaggy hawkweed plants were found. A new population of 12 pumice grapeferns was found growing along the roadside near the Grotto Cove overlook.

### Invasive Vegetation Management

A total of 51,281 invasive plants were removed from project areas during the 2017 season. Invasive plants were encountered most frequently at Rim Village. West Rim Drive was unable to be surveyed this year due to active road construction and fire closures. Most areas experienced an increase in invasive plant species this season (Table 11), which is not surprising given the amount of disturbance this area is receiving. A map of invasive plant locations is displayed in Figure 25.

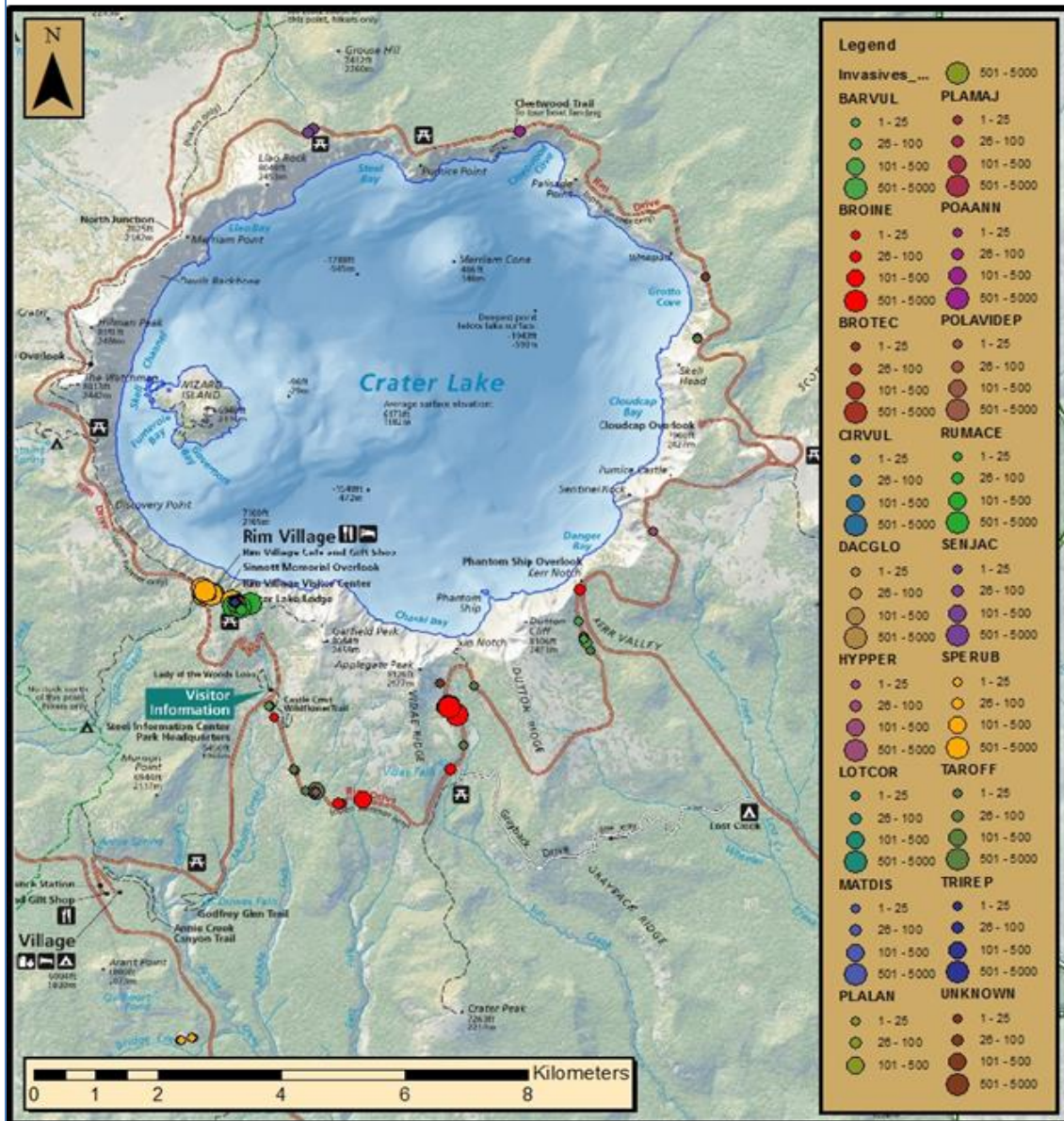


**Table 11.** Abundance (number of plants encountered) of invasive plants within the RDRR project area for 2017 and 2016.

<b>IVM Region</b>	<b>Invasive Plant Species</b>	<b>2017 Abundance</b>	<b>2016 Abundance</b>
Pole Bridge Creek Quarry	Yellow rocket ( <i>Barbarea vulgaris</i> )	10	227
	St. John's wort ( <i>Hypericum perforatum</i> )	0	2
	Sand spurry ( <i>Spergularia rubra</i> )	12	6
	Common dandelion ( <i>Taraxacum officinale</i> )	9	4
East Rim Drive	Yellow rocket	56	4
	Canola ( <i>Brassica napus</i> )	0	1
	Smooth brome ( <i>Bromus inermis</i> )	5,157	0
	Cheat grass ( <i>Bromus tectorum</i> )	1	1
	Common flixweed ( <i>Descurainia sophia</i> )	0	1
	St. John's wort	25	49
	Timothy ( <i>Phleum pretense</i> )	0	2
	Common plantain ( <i>Plantago major</i> )	0	1
	Annual bluegrass ( <i>Poa annua</i> )	40	115
	Common knotweed ( <i>Polygonum aviculare</i> ssp. <i>depressum</i> )	57	5
	Tansy ragwort ( <i>Senecio jacobaea</i> )	67	0
	Sand spurry	1	0
	Common dandelion	368	608
	White clover ( <i>Trifolium repens</i> )	0	10
West Rim Drive	Common knotweed	0	10
	Sheep sorrel	0	18
	Sand spurry	0	1624
	Common dandelion	0	1
Rim Village	Yellow rocket	640	363
	Bull thistle ( <i>Cirsium vulgare</i> )	1	1
	Orchard grass ( <i>Dactylis glomerata</i> )	2	0
	Broadleaf cottonrose ( <i>Filago pyramidata</i> var. <i>pyramidata</i> )	0	10
	St. John's wort	4	1
	Birdsfoot trefoil ( <i>Lotus corniculatus</i> )	1	0
	Pineapple weed ( <i>Matricaria discoidea</i> )	725	601
	English plantain ( <i>Plantago lanceolata</i> )	3	0
	Common plantain	17	5
	Annual bluegrass	40	0
	Common knotweed	762	0
	Sheep sorrel	25,998	14,639
	Sand spurry	16,490	8,361
	Common dandelion	260	2,188
	White clover	535	1,328
	Flannel mullein ( <i>Verbascum thapsus</i> )	0	1
<b>Total</b>	<b>51,281</b>	<b>29,590</b>	

# INVASIVE PLANT SPECIES AND ABUNDANCE

## RIM DRIVE REHABILITATION PROJECT



Document location: R:\BOTANY\Ecological Restoration\Rim Drive Rehabilitation project\Invasive Plants\maps\IVM Rim Project map.docx  
 ArcGIS Map location: R:\GIS\UserMaps\restoration\_projects\rim\_drive\maps\2017\_Invasives\_All\_RDRP.mxd

Species codes: BARVUL = yellow rocket; BROINE = smooth brome; BROTEC = cheat grass; CIRVUL = bull thistle; DACGLO = orchard grass; HYPPER = St. John's wort; LOTCOR = birds-foot trefoil; MATDIS = pineapple weed; PLANLAN = English plantain; PLAMAJ = plantain; POAANN = bluegrass; POLAVIDEP = knotweed; RUMACE = sheep sorrel; SENJAC = Tansy ragwort; SPERUB = sand spurry; TAROFF = dandelion; and TRIREP = white clover.

Figure 25. Treated invasive plant species by abundance in RDRR areas for 2017. Map by Tara Chizinski.

Common plantain, pineapple weed, and St. John's Wort populations were treated in their entirety with all observed individuals removed. However, large invasive plant populations of yellow rocket, sheep sorrel, and white clover at Rim Village were treated as time allowed. Sheep sorrel, which is rhizomatous, was treated in the entirety of its area but some individuals were undoubtedly missed, and some individuals had already resprouted by the end of the season.

## **Discussion**

The current phase of the Rim Drive Rehabilitation project was scheduled for completion in fall 2017; however, due to the contractor being behind schedule in many locations, the road rehabilitation will continue into the 2018 field season. The revegetation workload in 2018 will be very large, owing to the number of obliterated pullouts and unanticipated areas of disturbance which are scheduled to be ready for revegetation and restoration (Appendix A). Monitoring and continuing to complete site documentation of areas that underwent restoration work during the 2016 and 2017 field seasons will aid in evaluating the success of these efforts. These evaluations are vital for tracking efficacy of restoration efforts, identifying areas which need additional plant materials, and for informing managers in the planning of future restoration efforts.

Recommendations and needs for RDRR work in the 2018 field season include:

- Continue to create, update, and refine revegetation prescriptions and complete site documentation for each disturbance area, including areas that experienced unanticipated and excessive disturbance during road rehabilitation in 2017. Obtain area estimates of new disturbance areas and share with DSC Revegetation staff. Continue to monitor disturbed areas on an annual basis.
- The RDRR program now has the ability to clean seed in-house. Any successful techniques and methods should be documented for each species and added to the Seed Collecting and Cleaning Protocols.
- Seed collection can include additional species that aren't currently on species accession lists for Corvallis PMC seed cleaning and propagation. These species can be cleaned in-house when short-term storage is required, or stored uncleaned for dispersion in the autumn of the same year. Species should be chosen based on abundance in the specific area, as well as ease of collection. Mixing these additional seeds into site-specific mixes will help bulk up seed amounts distributed to the sites, provide extra compost and carrying material, as well as fine-tuning restoration prescriptions to reflect vegetation communities at unique sites.
- The CRLA Revegetation program now has the beginnings of a plant propagation program. Any attempts to propagate CRLA native species should be thoroughly documented to guide propagation efforts in the future. The Native Plant Network has propagation protocols for many species online: <https://nnp.rngr.net/propagation/protocols>

- All plants that overwintered in 2017/2018 need to be transplanted into larger containers as soon as practical after melt-out. The plants selected for overwintering were chosen because of their quick root development and overall hardiness. If plants aren't transplanted, many will die due to being extremely root bound. Care should be taken to not expose newly transplanted plants to water/light/temperature shock. All of these plants should be out-planted in 2018.
- The salvaged plants remaining from the 2017 season will need fertilization to assist with survival and growth. There are currently no amendments in the soil these plants are growing in.
- Surveys in areas with previously documented invasive plant populations should be conducted several times during the growing season, with priority given to areas near rare plant populations (e.g., Diamond Lake overlook, the Watchman, Grotto Cove, and Skell Head). The entire project area needs to be thoroughly surveyed for invasive plants at least twice throughout the field season, including staging areas and quarries.
- Continue to survey staging areas used by the 2014 Pavement Preservation project, including Pole Bridge Creek Quarry; Roundtop Quarry; the Ballfield; Cloudcap Spur Road and its intersection with East Rim Drive; the intersection of East Rim Drive and Pinnacles Road; the North Junction parking area; and the intersection of West Rim Drive with the North Entrance Road. Roads within the RDRR project area treated by the chip-seal project include Cloudcap Spur Road, the intersection of West Rim Drive with Munson Valley Road, and the intersection of East Rim Drive with Munson Valley Road.
- The National Weather Service has an extremely useful weather database with daily, monthly, and yearly data summaries (<http://w2.weather.gov/climate/xmacis.php?wfo=mfr>) that help inform when to water newly planted seedlings and provides information for seed collection. It also facilitates year-to-year comparisons by providing data on annual snow loads and precipitation amounts.
- In collaboration with the DSC Revegetation staff, the original plant propagation schedule has been altered to reflect the construction delays. In autumn of 2018, 2,900 plants will be grown for delivery and planting; 7,100 plants will be grown for delivery and planting in autumn of 2019 (Table 12).

**Table 12.** Proposed RDRR plant delivery numbers by plant species for 2018 and 2019.

Seed Zone	Plant Species	# to Propagate 2018	# to Propagate 2019	# CRLA currently has	total # of plants
South WRD	<i>Achnatherum occidentale</i>	1,050	0	0	1,050
	<i>Bromus carinatus</i> var. <i>carinatus</i>	700	0	0	700
	<i>Ericameria greenei</i>	0	1,000	0	1,000
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	1,150	0	0	1,150
	<i>Eriogonum marifolium</i>	0	100	0	100
	<i>Phlox diffusa</i>	0	600	0	600
	TOTAL	2,900	1,700	0	4,600
NW ERD	<i>Achnatherum occidentale</i>	0	300	87	387
	<i>Aconogonon davisiae</i> var. <i>davisiae</i>	0	400	37	437
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	0	0	851	851
	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	0	100	0	100
	<i>Juncus parryi</i>	0	100	148	248
	<i>Luetkea pectinata</i>	0	300	96	396
	<i>Lupinus lepidus</i> var. <i>lobbii</i>	0	0	1	1
TOTAL	0	1,200	1,220	2,420	
NE ERD	<i>Achnatherum occidentale</i>	0	600	0	600
	<i>Arctostaphylos nevadensis</i>	0	0	394	394
	<i>Arctostaphylos patula</i>	0	0	101	101
	<i>Bromus carinatus</i>	0	0	784	784
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	0	0	633	633
	<i>Ericameria nauseosa</i>	0	0	97	97
	<i>Phacelia hastata</i> ssp. <i>compacta</i>	0	250	0	250
TOTAL	0	850	2,009	2,859	
North WRD	<i>Achnatherum occidentale</i>	0	500	0	500
	<i>Aconogonon davisiae</i> var. <i>davisiae</i>	0	250	167	417
	<i>Carex breweri</i>	0	0	807	807
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	0	0	636	636
	<i>Ericameria greenei</i>	0	100	0	100
	<i>Eriogonum marifolium</i> var. <i>marifolium</i>	0	0	0	0
	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	0	0	460	460

Seed Zone	Plant Species	# to Propagate 2018	# to Propagate 2019	# CRLA currently has	total # of plants
	<i>Penstemon davidsonii</i> var. <i>davidsonii</i>	0	50	77	127
	<i>Phlox diffusa</i>	0	400	0	400
	TOTAL	0	1,300	2,147	3,447
Central WRD	<i>Achnatherum occidentale</i>	0	450	174	624
	<i>Aconogonon davisiae</i> var. <i>davisiae</i>	0	400	98	498
	<i>Boechera horizontalis</i>	0	0	411	411
	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	0	500	252	752
	<i>Ericameria greenei</i>	0	200	0	200
	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	0	300	25	325
	<i>Eriogonum marifolium</i> var. <i>marifolium</i>	0	0	27	27
	<i>Phlox diffusa</i>	0	200	232	432
	TOTAL	0	2,050	1,219	3,269
<b>TOTALS</b>		<b>2,900</b>	<b>7,100</b>	<b>6,595</b>	<b>16,595</b>

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## Appendix A – RDRR Master Revegetation List

The Master Revegetation List corresponds with the construction plan sets for the Rim Drive Rehabilitation project.

Seed Zone	Site ID#	Site Name	Station (Plan Set)	Left/ Right Side	Page (Plan Set)	Disturbance Type	Location Description	Area (ft <sup>2</sup> )	Planted/ Seeded 2016 - 2017
South WRD	SWRD1	Start Left	1+04; 3+64	Lt	D.4	Pullout to obliterate	Near Rim Village	3,807	No
	SWRD2	Start Right	1+45; 4+11	Rt	D.4	Pullout to obliterate	Near Rim Village	1,818	No
	SWRD3	Holodiscus PO	11+28; 13+50	Lt	D.5	Pullout to obliterate	North of weather station	3,024	No
	SWRD4	Rocky	23+23; 24+08	Lt	D.5	Pullout to obliterate	North of weather station	900	No
	SWRD5	Disco Pt.	48+41; 53+53	Rt	D.7	Pullout to obliterate	South of Discovery Point	9,360	No
	SWRD6	Lightning Springs	117+43; 120+51	Lt	D.12; E.4	Shrink parking area	Lightning Springs Trailhead Parking	1,053	No
Central WRD	CWRD1	Blind PO	131+34; 132+91	Lt	D.13	Pullout to obliterate	North of Lightning Springs	3,465	No
	CWRD2	Paintbrush PO	143+20; 146+02	Lt	D.13	Pullout to obliterate	Union Peak Grade	2,862	No
	CWRD3	BOEHOR	160+65; 175+02	Lt/Rt	D.15	Rare plant reestablishment	Watchman Grade	12,689	Yes
	CWRD4	BOEHOR/sand spurry PO	168+75; 169+50	Lt	D.15	Pullout to obliterate	Watchman Grade	915	No
	CWRD4.0 1	Pullout on watchman grade by rock wall	172+10; 174+52	Lt.	D.15	Excessive disturbance while fixing pullout	Watchman Grade	2540	Yes
	CWRD4.1	Below Watchman Trail	186+25; 189+75	Rt	D.16	Road stabilization	Watchman Grade	6232	Yes
	CWRD4.2	Area by curb at start of Watchman trail	193+62; 197+44	Rt.	D.17	Disturbance due to curb work	Watchman overlook	807	yes
	CWRD5	Rock island by road	200+25; 205+52	Rt	D.17; I.5	Landscape strip/islands	Watchman Overlook	1044	No
	CWRD6	Parking lot islands	200+20; 201+08	Rt	D.17	Landscape island	Watchman Overlook	1399	No
CWRD7	Hillman south	213+89; 215+25	Lt	D.18	Pullout to obliterate	Hillman Peak	1,440	No	
CWRD8	Hillman north	216+10; 217+29	Lt	D.18	Pullout to obliterate	Hillman Peak	1,808	Yes	
North WRD	NWRD1	Last Snow PO	259+20; 264+53	Rt	D.21;	Shrink parking area	Last Snow	3,726	No

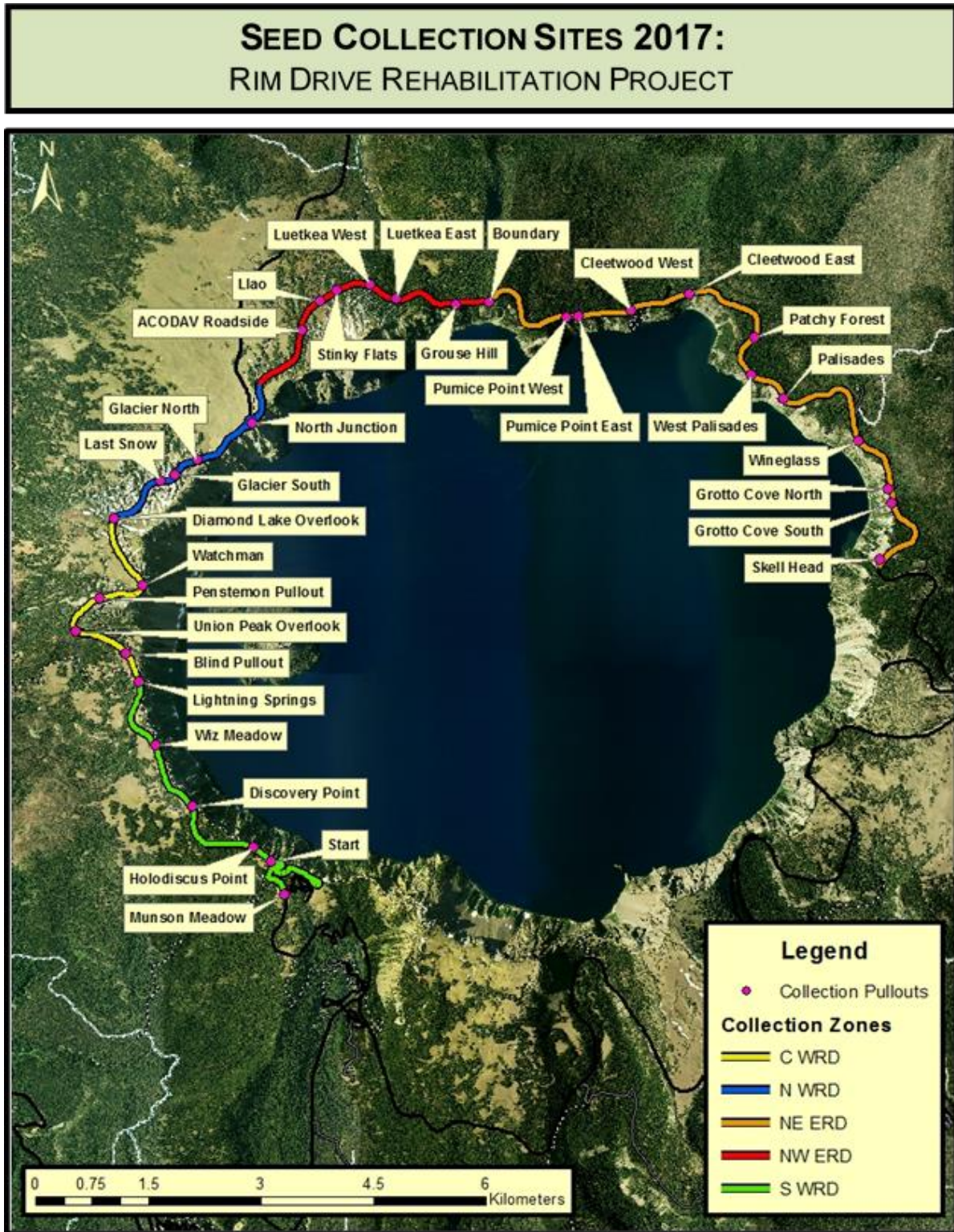


Seed Zone	Site ID#	Site Name	Station (Plan Set)	Left/ Right Side	Page (Plan Set)	Disturbance Type	Location Description	Area (ft <sup>2</sup> )	Planted/ Seeded 2016 - 2017
					E.6				
	NWRD2	Last Snow PO	259+57; 264+14	Lt	D.21; E.6	Pullout to obliterate	Last Snow	7136	No
	NWRD3	Devil's Backbone	269+48; 273+17	Lt	D.22	Pullout to obliterate	Devil's Backbone	3,690	No
	NWRD4	Devil's Backbone	279+35; 281+13	Lt	D.22, D.23	Pullout to obliterate	Devil's Backbone	1,810	No
	NWRD5	Grandmother Tree	297+18; 299+72	Rt	D.24, E.7	Shrink parking area	Glacial Valleys	2,565	No
	NWRD6	Combined with NWRD5	297+27; 299+24	Rt	D.24, E.7	Shrink parking area	Glacial Valleys		No
Northwest ERD	NWERD1	North Junction right	503+51; 507+03	Rt	D.26	Pullout to obliterate	North Junction	1,453	No
	NWERD1. 1	Directly next to NWERD1	502+06; 503+60	Rt	D.26	Ditch reconditioning	North Junction	2,045	Yes
	NWERD2	North Junction left	503+93; 508+38	Lt	D.26	Pullout to obliterate	North Junction	4,209	No
	NWERD2. 1	North Junction deep patch	510+00; 513+40	Lt	D.26	Deep patch	North Junction	~12,46 4	Yes
	NWERD2. 2	First staging area after North Junction	514+59; 522+44	Lt	D.27	Staging area erosion and damage	Llao Rock		No
	NWERD3	Llao south	560+75; 564+21	Lt	D.28	Pullout to obliterate	Llao Rock	4,180	No
	NWERD4	Llao north	566+91; 568+50	Lt	D.28	Pullout to obliterate	Llao Rock	3,832	No
	NWERD5	Luetkea west	588+42; 594+25	Lt	D.29	Pullout to obliterate	Grouse Hill	6,663	No
	NWERD5. 1	First paved area after Llao north	573+08; 572+82	Lt	D.28	Road stabilization	Llao Rock	1,604	Yes
	NWERD6	Luetkea east	603+35; 606+35	Lt	D.29/3 0	Pullout to obliterate	Grouse Hill	2,443	No
	NWERD7	Grouse Hill Picnic Area island	631+76; 633+53	Lt	D.30	Ditch reconditioning	Grouse Hill	2,530	Yes
	NWERD8	Roadside after Grouse Hill Picnic Area	633+75; 636+75	Rt	D.30/3 1	Deep patch	Grouse Hill Picnic	3,423	Yes
	NWERD8. 1	Lakeside area directly before Steel Bay	638+40; 639+18	Rt	D.31	Road stabilization	Steel Bay	~1,770	Yes
NWERD9	Flat area across	633+75; 636+75	Lt	D.30/3	Road stabilization	Grouse Hill Picnic	1,970	No	

Seed Zone	Site ID#	Site Name	Station (Plan Set)	Left/ Right Side	Page (Plan Set)	Disturbance Type	Location Description	Area (ft <sup>2</sup> )	Planted/ Seeded 2016 - 2017
		from Steel Bay			1				
	NWERD10	Across from Steel Bay PO	639+40	Lt	D.31	Culvert installation	Steel Bay	~8,700	Yes
	NWERD10 .1	Roadside after Steel Bay PO	646+78; 647+71	Rt	D.31	Slope erosion	Steel Bay	1,005	Yes
Northeast ERD	NEERD0.0 1	Area between Steel Bay & Pumice Point Comfort Station	673+90; 676+70	Lt	D.32	Deep patch	Pumice Point	6,721	Yes
	NEERD0.0 2	Right before PPCS	688+89; 691+04	Lt	D.33	Road stabilization	Pumice Point	6,255	Yes
	NEERD0.1	PPCS-west	691+04; 693+31	Lt	D.33	Excessive disturbance	Pumice Point	3,455	Yes
	NEERD0.1 5	PPCS-east	691+04; 693+31	Lt	D.33	Excessive disturbance	Pumice Point	1,496	Yes
	NEERD1	Right after PPCS	696+21; 698+71	Rt	D.34	Road realignment	Pumice Point	16,189	Yes
	NEERD1.1	Pumice Point caldera slope	698+52; 697+07	Rt	D.34	Excessive disturbance	Pumice Point	2,583	Yes
	NEERD1.2	Pumice Point unplanned ditch	719+33; 721+44	Lt	D.35	Wide ditch	Pumice Point	4,564	Yes
	NEERD1.2 5	After second pullout after PPCS	719+33; 721+44	Lt	D.35	Wide ditch	Pumice Point	3,638	Yes
	NEERD1.3	Pullout with drain across road	721+44	Lt	D.35	Culvert placement	West of Cleetwood Cove	883	Yes
	NEERD2	Cleetwood west	731+89; 735+23	Lt	D.35/3 6	Pullout to obliterate	Cleetwood Cove	2,565	No
	NEERD2.1	Paved area before Cleetwood (next to NEERD1.3)	732+40; 735+60	Rt	D.35/3 6	Deep patch	Cleetwood Cove	6,945	No
	NEERD3	Cleetwood parking lot	738+74; 10+00	n/a	1.9	Landscape islands/ Landscaping for visitor facilities	Cleetwood Cove		some
	NEERD3.1	Cleetwood parking lot	738+74; 10+00	n/a	1.9	Logs staged on slope	Cleetwood Cove	11,711	some
	NEERD3.2	Cleetwood overlook	738+74	Rt.	1.9	Overlook construction	Cleetwood Cove		No

Seed Zone	Site ID#	Site Name	Station (Plan Set)	Left/ Right Side	Page (Plan Set)	Disturbance Type	Location Description	Area (ft <sup>2</sup> )	Planted/ Seeded 2016 - 2017
						disturbance			
	NEERD4	Past Cleetwood	739+31; 750+02	Lt	D.36	Pullout to obliterate	Cleetwood Cove	7,434	No
	NEERD5	Past Cleetwood	742+38; 744+94	Rt	D.36	Pullout to obliterate	Cleetwood Cove	2,223	No
	NEERD15	Grotto Cove	n/a	Lt/Rt	n/a	Realignment, stabilization	Grotto Cove emergency stabilization	~12,53 9	Yes

## Appendix B – Seed Collection Site Locations



Document location: R:\BOTANY\Ecological Restoration\Rim Drive Rehabilitation project\Seed Collection\  
Seed\_collection\2017\2017 seed collection sites map.docx

ArcGIS Map location: R:\GIS\UserMaps\restoration\_projects\rim\_drive\Seed Collection\_Sites 2017

SOUTH WEST RIM DRIVE		
Munson Meadow (569663E, 4750963N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Boechera howellii</i></li> <li>• <i>Carex pachycarpa</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Eremogone pumicola</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus andersonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Start Meadow (569491E, 4751426N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> <li>• <i>Carex halliana</i></li> <li>• <i>Carex pachycarpa</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Elymus glaucus</i> ssp. <i>glaucus</i></li> <li>• <i>Ericameria greenei</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eucephalus ledophyllus</i></li> <li>• <i>Lupinus andersonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Holodiscus Pullout (569253E, 4751604N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> <li>• <i>Carex halliana</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria greenei</i></li> <li>• <i>Holodiscus microphyllus</i> var. <i>glaberscens</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus andersonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Discovery Point (568453E, 4752173N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> <li>• <i>Calyptridium umbellatum</i></li> <li>• <i>Carex halliana</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Carex pachycarpa</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria greenei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> <li>• <i>Holodiscus microphyllus</i> var. <i>glaberscens</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Wiz Meadow (567957E, 4752980N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Anaphalis margaritacea</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> <li>• <i>Calyptridium umbellatum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Carex halliana</i></li> <li>• <i>Carex pachycarpa</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria greenei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> <li>• <i>Lupinus andersonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Lightning Springs (567731E, 4753860N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> <li>• <i>Calyptridium umbellatum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Carex halliana</i></li> <li>• <i>Carex pachycarpa</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Lupinus andersonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>

CENTRAL WEST RIM DRIVE		
Lightning Springs (567731E, 4753860N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Calyptridium umbellatum</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus andersonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Blind Pullout (566958E, 4753456N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria greenei</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Union Peak Overlook (566885E, 4754541N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Castilleja applegatei</i></li> <li>• <i>Castilleja arachnoidea</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria greenei</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Penstemon davidsonii</i> var. <i>davidsonii</i></li> </ul>
Penstemon Pullout (567202E, 4754971N)		
<ul style="list-style-type: none"> <li>• <i>Penstemon davidsonii</i> var. <i>davidsonii</i></li> </ul>		
Watchman (567785E, 4755150N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Anemone occidentalis</i></li> <li>• <i>Castilleja applegatei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria greenei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Diamond Lake Overlook (567389E, 4756062N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Carex breweri</i></li> <li>• <i>Castilleja applegatei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Penstemon davidsonii</i> var. <i>davidsonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>

NORTH WEST RIM DRIVE		
Diamond Lake Overlook (567389E, 4756062N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Carex breweri</i></li> <li>• <i>Castilleja applegatei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> <li>• <i>Penstemon davidsonii</i> var. <i>davidsonii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Last Snow (568016E, 4756558N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Carex breweri</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja applegatei</i></li> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> <li>• <i>Penstemon davidsonii</i> var. <i>davidsonii</i></li> </ul>
Glacier South (568215E, 4756658N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Carex breweri</i></li> <li>• <i>Castilleja applegatei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
Glacier North (568505E, 4756850N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Carex breweri</i></li> <li>• <i>Castilleja applegatei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>
North Junction (569240E, 4757339N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Calyptridium umbellatum</i></li> <li>• <i>Carex breweri</i></li> <li>• <i>Castilleja applegatei</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria greenei</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Lupinus andersonii</i></li> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> <li>• <i>Phlox diffusa</i></li> </ul>

NORTHWEST EAST RIM DRIVE		
North Junction (569240E, 4757339N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Calyptridium umbellatum</i></li> <li>• <i>Carex breweri</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja applegatei</i></li> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
ACODAV Roadside (569862E, 4758457N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Juncus parryi</i></li> </ul>
Llao (570139E, 4758986N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Aconogonon davisiae</i> var. <i>davisiae</i></li> <li>• <i>Boechera howellii</i></li> <li>• <i>Carex breweri</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Castilleja applegatei</i></li> <li>• <i>Castilleja arachnoidea</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Eremogone pumicola</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> <li>• <i>Juncus parryi</i></li> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
Stinky Flats (570364E, 4759151N)		
<ul style="list-style-type: none"> <li>• <i>Calyptridium umbellatum</i></li> <li>• <i>Eriogonum marifolium</i> var. <i>marifolium</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
Luetkea West (570788E, 4759198N)		
<ul style="list-style-type: none"> <li>• <i>Boechera howellii</i></li> <li>• <i>Juncus parryi</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Luetkea pectinata</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
Luetkea East (571165E, 4759019N)		
<ul style="list-style-type: none"> <li>• <i>Boechera howellii</i></li> <li>• <i>Carex breweri</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Juncus parryi</i></li> <li>• <i>Luetkea pectinata</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
Grouse Hill (571945E, 4758953N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> </ul>	
Boundary Pullout (577402E, 4758993N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Calyptridium umbellatum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Juncus parryi</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>



NORTHEAST EAST RIM DRIVE		
Boundary Pullout (577402E, 4758993N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Calyptridium umbellatum</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Juncus parryi</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
Pumice Point West (573440E, 4758788N)		
<ul style="list-style-type: none"> <li>• <i>Arctostaphylos nevadensis</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Arctostaphylos patula</i></li> </ul>	
Pumice Point East (573592E, 4758794N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Arctostaphylos nevadensis</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Arctostaphylos patula</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Carex halliana</i></li> </ul>
Cleatwood West (574287E, 4758867N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Arctostaphylos nevadensis</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Arctostaphylos patula</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> </ul>
Cleatwood East (575061E, 4759098N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Arctostaphylos nevadensis</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Arctostaphylos patula</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Ericameria nauseosa</i> var. <i>speciosa</i></li> </ul>
Patchy Forest (575947E, 4758497N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
West Palisades (575881E, 4757981N)		
<ul style="list-style-type: none"> <li>• <i>Arctostaphylos nevadensis</i></li> <li>• <i>Arctostaphylos patula</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria nauseosa</i> var. <i>speciosa</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> <li>• <i>Phacelia hastata</i> ssp. <i>compacta</i></li> </ul>
Palisades (576324E, 4757676N)		
<ul style="list-style-type: none"> <li>• <i>Arctostaphylos nevadensis</i></li> <li>• <i>Arctostaphylos patula</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> <li>• <i>Ericameria nauseosa</i> var. <i>speciosa</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
Wineglass (577330E, 4757108N)		
<ul style="list-style-type: none"> <li>• <i>Arctostaphylos nevadensis</i></li> <li>• <i>Arctostaphylos patula</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Diplacus nanus</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Ericameria nauseosa</i> var. <i>speciosa</i></li> </ul>
Grotto Cove North (577726E, 4756459N) and Grotto Cove South (577766E, 4756241N)		
<ul style="list-style-type: none"> <li>• <i>Arctostaphylos nevadensis</i></li> <li>• <i>Arctostaphylos patula</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Diplacus nanus</i></li> <li>• <i>Ericameria nauseosa</i> var. <i>speciosa</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> </ul>
Skell Head Pullout (577601E, 4755494N)		
<ul style="list-style-type: none"> <li>• <i>Achnatherum occidentale</i></li> <li>• <i>Bromus carinatus</i> var. <i>carinatus</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Carex halliana</i></li> <li>• <i>Elymus elymoides</i> ssp. <i>elymoides</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Lupinus lepidus</i> var. <i>lobbii</i></li> <li>• <i>Phacelia hastata</i> ssp. <i>compacta</i></li> </ul>

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

April 2018

**National Park Service**  
**U.S. Department of the Interior**



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