



Rim Drive Rehabilitation Revegetation Project

2022 Annual Report





ON THIS PAGE

Collecting bush ocean spray (*Holodiscus microphyllus* var. *glabrescens*) seed along East Rim Drive.
Photo by Eleanor Roeder.

ON THE COVER

Flowering plants along the East Rim Drive road shoulder.
Photo by Carrie Wyler.

Rim Drive Rehabilitation Revegetation Project

2022 Annual Report

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Crater Lake National Park
Crater Lake, Oregon

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

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

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

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Abstract

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 project is correcting many deficiencies present along the park's historic Rim Drive and has been split into phases encompassing iterative work progression. Revegetation work for Phase II commenced in the 2020 season with construction anticipated to start in June 2023. Through developing revegetation prescriptions, 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 2022 field season, 7,441 invasive plants were controlled from within the project area. Revegetation prescriptions were completed for 29 identified restoration sites. Plant materials were collected from five distinct seed zones representing the floral diversity of the Phase II project area. Nineteen seed accessions were provided to the U.S. Forest Service Dorena Genetic Resource Center for cleaning, and 16 seed accessions were cleaned by park staff. Approximately 766 rare plants were salvaged from the project area. Documentation was refined for each restoration site to inform future efforts and assess revegetation efficacy.

Acknowledgments

The Crater Lake National Park Facility Management staff allowed use of the Ball Diamond and South Yard staging areas for storage of plant materials and related infrastructure. Assistance with seed collection and planting was received from members of the Crater Lake National Park Terrestrial Ecology staff and the Northwest Youth Corps. The Meeker Plant Materials Center provided seed storage. The U.S. Forest Service Dorena Genetic Resource Center aided with seed cleaning and storage.

Introduction

The Federal Highway Administration (FHWA)-sponsored Rim Drive Rehabilitation 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.

Phase I of the Rim Drive Rehabilitation project was initiated in 2014 and focused on rockfall mitigation and road rehabilitation along sections of Rim Drive. In 2015 road rehabilitation work affected six 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. Major construction work on Phase I was completed in November 2018 and revegetation work was completed in 2021. Phase II will complete the remainder of the Rim Drive Rehabilitation project, starting at Cleetwood Cove and heading clockwise around the rim to park headquarters. Revegetation work for Phase II commenced in 2020, and construction work is slated to begin during summer 2023. Phase II construction plans have detailed deep patch (Figure 1) and edge stabilization areas identified along the roadway, which allows for better planning. In addition to impacting roadways and road shoulders, numerous pullouts, parking areas, and parking lots will be modified. These modifications include obliterating unofficial pullouts (Figure 1), shrinking the footprint of excessively large parking areas (Figure 1), and installing landscaping islands in high visitor use areas. A master list of planned revegetation sites for Phase II of the project is provided in Appendix A, and a map of site locations is displayed in Figure 2.

Additionally, road work will affect numerous rare and/or sensitive plant populations and areas with unique vegetation communities within the project area (Figure 1). Due to the substantial impacts occurring to soils and vegetation, FHWA 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 a revegetation plan with prescriptions for disturbed areas to be restored.
2. Surveying for and controlling nonnative, 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.

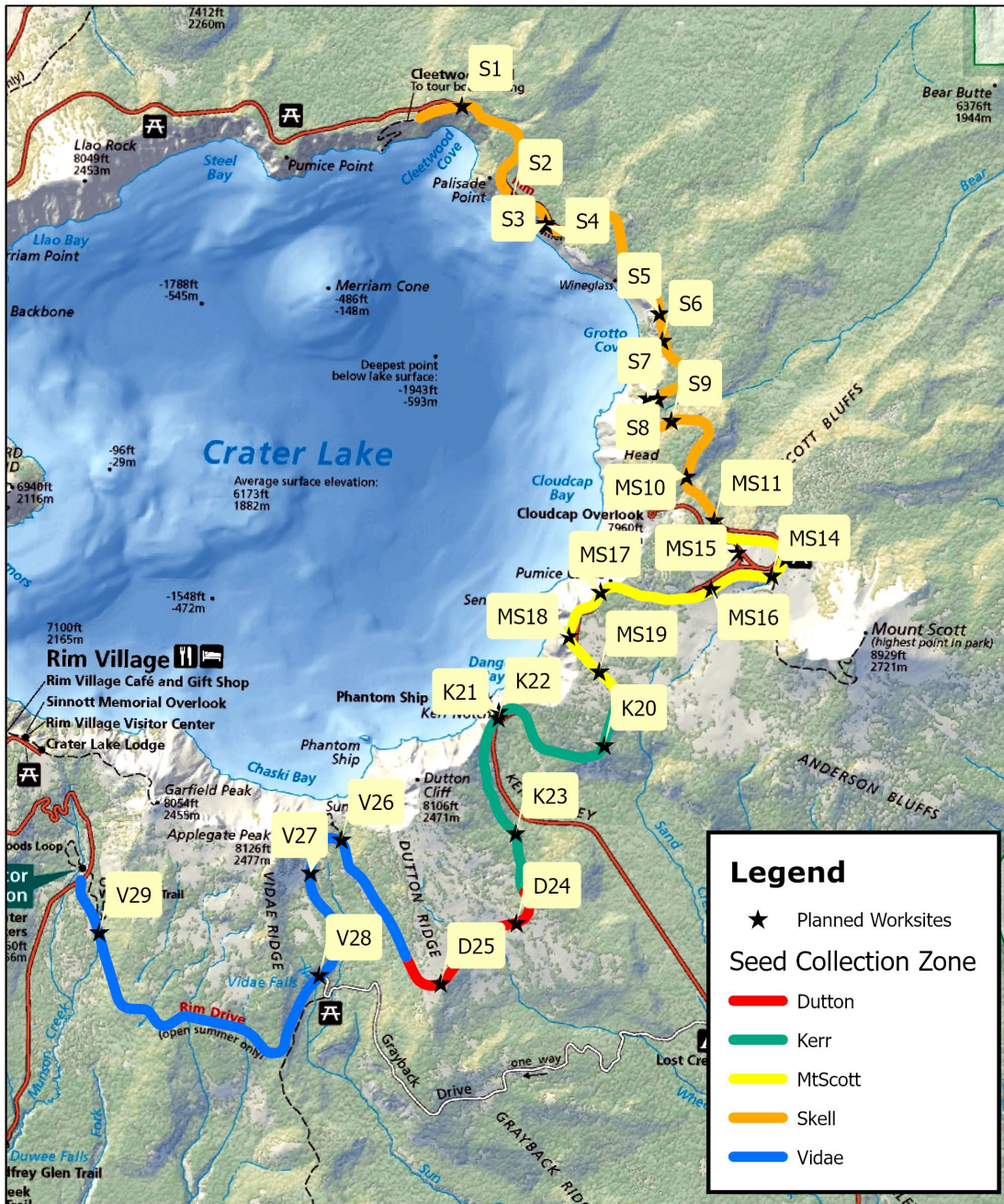


Figure 1. Top: Example of a deep patch area (left). Road stabilization section that will destroy a unique roadside riparian area as part of the Rim Drive Rehabilitation project (right). Bottom: User-created pullout (left). Example of an excessively wide pullout within the project area (right). Photos by Scott Heisler.

Crater Lake National Park

RDRR Phase 2 - Planned Worksites

National Park Service
U.S. Department of the Interior



Legend

- ★ Planned Worksites
- Seed Collection Zone
- Dutton
- Kerr
- MtScott
- Skell
- Vidae

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Date: 11/2/2021



Coordinate System:
NAD 1983 UTM Zone 10N



Document Path: R:\GIS\UserMaps\034_RDRR_Phase2\Worksites and Surveys\Maps_Projects\RDRR_Phase2_Worksites\RDRR_Phase2_Worksites.aprx

Figure 2. Map of planned revegetation sites by seed zone for Phase II of the RDRR project. Sites MS12 and MS13 are not displayed. Map by Scott Heisler.

Restoration of areas disturbed by the Rim Drive Rehabilitation project is necessary to jumpstart natural succession of vegetation communities, protect the rim environment from soil erosion, and prevent invasion by nonnative 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.

The 2022 field season focused on documenting restoration site prescriptions, refining a revegetation plan, gathering plant materials, and containerized plant care. Five seasonal Biological Science Technicians (Plants) were partially funded by the RDRR project in 2022; season length was from May 23rd to November 3rd.

While this report focuses on work accomplished during the 2022 field season and primarily tackles work related to Phase II of the Rim Drive Rehabilitation project, some ongoing work in Phase I areas is still occurring and is discussed here. Some Phase I restoration sites are faring poorly and still require revegetation efforts and attention. Additionally, invasive vegetation management work is discussed for the entire Rim Drive Rehabilitation project area, even though this work is being supported through other funding mechanisms.

Methods

Efforts made on the RDRR project in 2022 can be organized into three components: (1) revegetation, (2) special status plant management, and (3) invasive vegetation management; these are described below.

Revegetation

Site Prescriptions

Prior to construction, revegetation prescriptions were developed for each area slated for restoration. These prescriptions serve to document the pre-disturbance site features and plant community 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 (Figure 3). This documentation was established to inform revegetation efforts by providing a baseline from which to determine the quantities of plants and seed to be used at each site. Sometimes unanticipated disturbance results from construction; in these instances, *ex post facto* restoration prescriptions are developed from adjacent undisturbed plant communities and the restoration is deemed an “unplanned” site. For planned sites, photo points are established, and photos taken of each pre-disturbance site (Figure 3). The specifics of this process are outlined in a project-specific revegetation plan (Wyler and Hooke 2023). Revegetation prescriptions and the revegetation plan are housed on the Botany file server at park headquarters.



Figure 3. Documenting a site that will be impacted by the Rim Drive Rehabilitation project (left). Photo documentation of a unique roadside plant population that will be destroyed by roadside edge stabilization treatments during Phase II of the RDRR project (right). Photos by Carrie Wyler.

Seed Collection

The Phase II RDRR project area was delineated into seed zones, with each zone 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 2) were defined for Phase II of the project and named for prominent features in those areas:

- Skell
- Mt. Scott
- Kerr
- Dutton
- Vidae

Once seed zones were delineated, a discrete revegetation species list was developed for the project. To develop cost-effective agreements and work plans between CRLA and the partners with responsibility for seed cleaning, seed storage, and plant propagation for this project, it has been found that using eight to ten plant species (accessions) per seed zone is adequate for revegetation efforts. Species substitutions and species additions are made as necessary to help fill any gaps in the species accession list. The U.S. Forest Service Dorena Genetic Resource Center (DGRC) is assisting CRLA with seed cleaning, seed storage, and plant propagation for Phase II of the RDRR project.

Since the inception of Phase I of the RDRR project, CRLA has developed the capacity to clean and propagate a limited selection of plant species in-house. While maintaining eight to ten accessions per seed zone is still the goal when working with plant materials partners, additional plant species have been included for Phase II seed zones that will be cleaned and propagated at the Botany program's

Ball Diamond native plant nursery at park headquarters. The core eight to ten accession species are designated as “priority” seed collection species (Table 1).

Denver Service Center (DSC) revegetation staff recommends collecting large quantities of seed from abundantly occurring species, as custom seed mixes can be supplemented with excess seed that can also be used to revegetate unanticipated disturbance areas. As per the “Seed Collection in National Parks” manual (Taliga et al. 2015), seed is collected ideally from 30 - 100 individual plants per population, taking care not to collect more than 20% of seed from the total population unless it is slated for removal due to construction, in which case as much seed as possible should be collected. Seed collection for Phase II continued in 2022 (Table 1).

Table 1. Phase II RDRR seed collection list per seed collection zone.

SEED ZONE	PLANT TAXA (Scientific name, common name)	
Skell	<i>Boechera horizontalis</i> —Crater Lake rockcress**	<i>Hieracium horridum</i> —Shaggy hawkweed**
	Undescribed <i>Boechera</i> **	<i>Holodiscus microphyllus</i> var. <i>glabrescens</i> * -- bush ocean spray
	<i>Calyptridium umbellatum</i> * --pussypaws	<i>Ipomopsis congesta</i> ssp. <i>montana</i> --palm leaf ballhead gilia
	<i>Carex pachycarpa</i> * --many-rib sedge	<i>Juncus parryi</i> * --Parry’s rush
	<i>Ceanothus prostratus</i> var. <i>prostratus</i> –Mahala mat	<i>Linanthus pungens</i> –granite gilia
	<i>Diplacus nanus</i> –dwarf monkeyflower	<i>Lupinus lepidus</i> var. <i>lobbii</i> * --prostrate lupine
	<i>Drymocallis glandulosa</i> var. <i>reflexa</i> –Montana sticky cinquefoil	<i>Oxyria digyna</i> –alpine sorrel
	<i>Ericameria nauseosa</i> var. <i>speciosa</i> * --showy rabbitbrush	<i>Packera cana</i> –wooly groundsel
	<i>Eriocoma occidentalis</i> * --western needlegrass	<i>Penstemon davidsonii</i> var. <i>davidsonii</i> – Davidson’s penstemon
	<i>Eriogonum marifolium</i> var. <i>marifolium</i> –marumleaf buckwheat	<i>Penstemon speciosus</i> –royal penstemon
	<i>Eriogonum nudum</i> var. <i>nudum</i> --barestem buckwheat	<i>Phacelia mutabilis</i> * --changeable phacelia
	<i>Eriogonum ovalifolium</i> var. <i>nivale</i> –Sierran cushion buckwheat	<i>Purshia tridentata</i> –antelope brush
Mt. Scott	<i>Koenigia davisiae</i> var. <i>davisiae</i> * --Davis’ knotweed	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i> –hairy Shasta buckwheat
	<i>Alnus alnobetula</i> ssp. <i>sinuata</i> –Sitka alder	<i>Eucephalus ledophyllus</i> –Cascade aster
	<i>Boechera howellii</i> –Howell’s flatseed rockcress	<i>Hieracium horridum</i> —Shaggy hawkweed**
	<i>Calyptridium umbellatum</i> * --pussypaws	<i>Hulsea nana</i> –dwarf hulsea
	<i>Carex pachycarpa</i> * --many-rib sedge	<i>Juncus parryi</i> * --Parry’s rush
	<i>Castilleja arachnoidea</i> --cobwebby paintbrush	<i>Lomatium martindalei</i> –Cascade desert parsley
	<i>Dieteria canescens</i> var. <i>shastensis</i> –rayless Shasta aster	<i>Lupinus lepidus</i> var. <i>lobbii</i> * --prostrate lupine
	<i>Ericameria greenei</i> * --Greene’s goldenbush	<i>Penstemon davidsonii</i> var. <i>davidsonii</i> – Davidson’s penstemon
	<i>Eriocoma occidentalis</i> * --western needlegrass	<i>Phacelia mutabilis</i> * --changeable phacelia

SEED ZONE	PLANT TAXA (Scientific name, common name)	
	<i>Eriogonum marifolium</i> var. <i>marifolium</i> * -- marumleaf buckwheat	<i>Raillardella argentea</i> --silky raillardella
Kerr	<i>Ageratina occidentalis</i> --western boneset	<i>Eriogonum marifolium</i> var. <i>marifolium</i> * - marumleaf buckwheat
	<i>Alnus alnobetula</i> ssp. <i>sinuata</i> --Sitka alder	<i>Eriogonum nudum</i> var. <i>nudum</i> --barestem buckwheat
	<i>Anaphalis margaritacea</i> --pearly everlasting	<i>Hackelia micrantha</i> -- blue stickseed
	<i>Arnica cordifolia</i> --heart-leaved arnica	<i>Holodiscus microphyllus</i> var. <i>glabrescens</i> * -- bush ocean spray
	<i>Arnica longifolia</i> --longleaf arnica	<i>Juncus parryi</i> * --Parry's rush
	<i>Calyptridium umbellatum</i> * ---pussypaws	<i>Lomatium martindalei</i> --Cascade desert parsley
	<i>Carex</i> species*	<i>Lupinus lepidus</i> var. <i>lobbii</i> * --prostrate lupine
	<i>Drymocallis glandulosa</i> var. <i>reflexa</i> * --sticky cinquefoil	<i>Penstemon rupicola</i> --cliff penstemon
	<i>Elymus glaucus</i> ssp. <i>glaucus</i> --blue wildrye	<i>Phacelia mutabilis</i> * --changeable phacelia
	<i>Ericameria greenei</i> * --Greene's goldenbush	<i>Raillardella argentea</i> --silky raillardella
	<i>Erigeron glacialis</i> var. <i>glacialis</i> --peregrine fleabane	<i>Ribes erythrocarpum</i> -- Crater Lake currant
	<i>Eriocoma occidentalis</i> * --western needlegrass	<i>Ribes lacustre</i> --swamp currant
Dutton	<i>Koenigia davisiae</i> var. <i>davisiae</i> * --Davis' knotweed	<i>Eriogonum marifolium</i> var. <i>marifolium</i> * -- marumleaf buckwheat
	<i>Anemone occidentalis</i> --western pasqueflower	<i>Eriogonum nudum</i> var. <i>nudum</i> --barestem buckwheat
	<i>Calyptridium umbellatum</i> * --pussypaws	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i> -- hairy Shasta buckwheat
	<i>Castilleja arachnoidea</i> --cobwebby paintbrush	<i>Eucephalus ledophyllus</i> --Cascade aster
	<i>Chaenactis alpina</i> --alpine chaenactis	<i>Juncus parryi</i> * -- Parry's rush
	<i>Dieteria canescens</i> var. <i>shastensis</i> --rayless Shasta aster	<i>Lupinus lepidus</i> var. <i>lobbii</i> * --prostrate lupine
	<i>Ericameria greenei</i> * --Greene's goldenbush	<i>Phacelia mutabilis</i> * --changeable phacelia
	<i>Eriocoma occidentalis</i> * --western needlegrass	<i>Raillardella argentea</i> --silky raillardella
Vidae	<i>Koenigia davisiae</i> var. <i>davisiae</i> * --Davis' knotweed	<i>Eriogonum marifolium</i> var. <i>marifolium</i> -- marumleaf buckwheat
	<i>Anemone occidentalis</i> --western pasqueflower	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i> -- hairy Shasta buckwheat
	<i>Arnica viscosa</i> --Shasta arnica**	<i>Erythranthe lewisii</i> --great purple monkeyflower
	<i>Calyptridium umbellatum</i> * --pussypaws	<i>Holodiscus microphyllus</i> var. <i>glabrescens</i> * -- bush ocean spray
	<i>Carex halliana</i> --Hall's sedge	<i>Juncus parryi</i> * -- Parry's rush
	<i>Carex pachycarpa</i> * --many-rib sedge	<i>Lupinus albicaulis</i> var. <i>shastensis</i> --pine lupine
	<i>Castilleja arachnoidea</i> --cobwebby paintbrush	<i>Lupinus lepidus</i> var. <i>lobbii</i> * --prostrate lupine
	<i>Elymus glaucus</i> ssp. <i>glaucus</i> --blue wildrye	<i>Penstemon davidsonii</i> var. <i>davidsonii</i> -- Davidson's penstemon
	<i>Ericameria greenei</i> * --Greene's goldenbush	<i>Phacelia mutabilis</i> * --changeable phacelia
	<i>Eriocoma occidentalis</i> * --western needlegrass	<i>Senecio triangularis</i> --arrowleaf groundsel
	<i>Erigeron glacialis</i> var. <i>glacialis</i> --peregrine fleabane	

* = Denotes priority seed collection species.

**=Denotes rare species.

Shaded plant species were not collected in 2022 but have been targeted for collection in the past and may be targeted in the future.

The seed collection process commenced in 2022 by observing and documenting the phenology of priority collection species at each revegetation site within the Phase II project area. Notes were taken on plant phenology, seed maturity, and seed collection techniques; these observations helped refine seed collection protocols (Beck et al. 2017). A map was developed for all seed collection locations in each seed zone (Figure 2).

When seeds were mature, they were collected, dried, and stored until shipment to the DGRC. Within each zone a single bag was used to collect all the seed from an individual species (Figure 4). 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 4). When seeds arrived at this facility, records were kept for each species with collection dates, specific collection location, and seed zone. Seeds were then placed inside 30-gallon plastic storage totes secured with window screen at the top, allowing ventilation while reducing chances of predation. Plant species with very small seeds were first placed in smaller plastic bins before being stored within the larger 30-gallon tubs (Figure 4). The bins were labelled and organized on shelves by seed zone and species.

Prior to shipping seed to the DGRC, 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 shortage of seed storage space at the park, and inadequate ventilation for effective drying of damp material.



Figure 4. Collected seed before cleaning (left). Seed drying and storage facility at park headquarters (middle). Seed drying in a container inside a drying bin with ventilated lid (right). Photos by Carrie Wyler.

Some species were not collected in 2022 due to the project timeline being delayed. At the time of this writing, construction is planned to progress in discrete segments that will be completed prior to beginning work in a new area. In Phase I of the project, construction work occurred in several areas

simultaneously with the revegetation work pushed toward the end of the project's duration. This iterative progression of Phase II of the project will make it easier to complete restoration at the end of each construction season instead of completing all the restoration for the project in a more condensed timeframe, making the project more manageable.

Plant Care and Nursery Work

Anticipating the need for established containerized plants for use in Phase II and the slow growth of native plants in the high elevation conditions at CRLA, an advance round of plant propagation was conducted at CRLA in fall 2020 and 2021. Approximately 130 pots were seeded for propagation in 2021 and are being held over at the Ball Diamond nursery at park headquarters. No plants were propagated in 2022 due to the project implementation being moved back to 2023. In 2022, bush ocean spray (*Holodiscus microphyllus* var. *glabrescens*) and Sitka alder (*Alnus alnobetula* ssp. *sinuata*) were found to be rootbound and were transplanted from jumbo pots to one-gallon tree pots. All plants will require care and maintenance throughout future field seasons. Once the snow melts in June, plants are covered with a shade house (40' x 20' x 10' – Figure 5).

A method of plant propagation previously established by the Botany program was utilized to address staffing and equipment limitations (Heisler et al. 2019). This method uses the snowpack at CRLA for cold stratification of pre-seeded pots. Selection of plant species and quantities for this effort were based upon the program's familiarity with the project area and experience gained from Phase I of the project. Additional difficult-to-propagate plant material needs for this project will be sourced through an interagency agreement with the DGRC.



Figure 5. Overwintered plants under snow with mulch around the edges of pots to insulate against frigid winter temperatures (left). Shadehouse at the Ball Diamond (right). Photos by Carrie Wyler.

When ambient temperature dropped below freezing the containers were consolidated and mulch was stacked around the perimeter of consolidated containers to prevent root freezing (Figure 5). These plants will need further care in the summer of 2023 including watering, fertilization, and transplanting into larger containers.

Special Status Plant Management

In the process of rehabilitating Rim Drive, many special status plant populations growing adjacent to Rim Drive have been or will be impacted. This includes populations of rare and sensitive plants such as Shasta arnica (*Arnica viscosa*), pumice moonwort (*Botrychium pumicola* - Figure 6), Crater Lake

rockcress, a currently undescribed species of rockcress (*Boechera* undescribed), shaggy hawkweed (*Hieracium horridum* - Figure 6), and whitebark pine (*Pinus albicaulis*).



Figure 6. Pumice moonwort (left) and shaggy hawkweed (right). Photos by NPS staff.

To mitigate impacts to the park’s special status plant species, baseline information is collected on pre-disturbance plant populations and seed is collected from rare plants (Figure 7) for future propagation and revegetation efforts. Rare plant populations are mapped, and census data collected for each population (Figure 7). Wherever possible, special status plant species are protected from construction impacts. When impacts are unavoidable, rare plants are salvaged as feasible, cared for at a holdover facility, and transplanted back into their habitat post-disturbance outside the footprint of recurring disturbance. Additionally, supplemental planting of propagated rare plants is conducted, and reestablished populations are monitored to ensure successful reestablishment. Extensive portions of East Rim Drive will be impacted by deep patch and edge stabilization work. These areas were surveyed for rare plants, and those encountered were documented with a submeter GNSS receiver using real-time SBAS correction (EOS Arrow 100).



Figure 7. Collecting seed from shaggy hawkweed (left). Crater Lake rockcress population census (middle). Mapping shaggy hawkweed (right). Photos by Carrie Wyler.

Due to the high probability of this project to disturb or eliminate plants in the road prism it was decided to salvage as many rare plant species that may be affected as practical. Soon-to-be disturbed plants were excavated with hand trowels and transplanted into pots using local soil to maintain soil biological associations and soil composition (Figure 8). Plants were then transported to the park’s native plant nursery at the Ball Diamond, where they were placed in a shadehouse. These plants will be cared for until they are returned to their original locations post-construction where they will be planted just beyond the zone of regular roadside maintenance.



Figure 8. Salvaging pumice moonwort from East Rim Drive roadside (left). Carefully transplanting undescribed *Boechera* into pots from projected disturbance areas (right). Photos by Carrie Wyler.

Five-needle pine species (Figure 9) are declining throughout their ranges due to their susceptibility to the disease white pine blister rust, caused by the nonnative fungal pathogen *Cronartium ribicola* among other factors. Two five-needle pine species occur within the road prism of the project area: whitebark pine (*Pinus albicaulis*) and western white pine (*Pinus monticola*). The U.S. Fish and Wildlife Service has recently listed whitebark pine as a threatened species under the Endangered Species Act; western white pine is a CRLA species of management concern. To better protect these iconic trees against impacts from construction activities, a survey of five needle pine species was conducted in 2020 in areas where high levels of roadside disturbance were anticipated. This survey provided precise locations of these species for incorporation into project plans and serves as a monitoring reference for the CRLA Botany program. All whitebark pine within the project area will be flagged, fenced, and protected from project impacts whenever possible.



Figure 9. Whitebark pine (left) and western white pine (right). Photos by Jen Hooke.

Invasive Vegetation Management

Crater Lake National Park has assigned all its 96 nonnative 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 vegetation communities are relatively pristine and lacking nonnative plant 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 and/or sensitive 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 low abundances of invasive plants, invasive plant populations along Rim Drive and project staging areas often have reduction or eradication strategies.

In 2022, most of the project area was surveyed for nonnative, invasive plant species (Figure 10). Roadsides were surveyed throughout the season by foot. Project staging areas (Roundtop Quarry, the Ball Diamond, Pole Bridge Creek Quarry, and the junction of East Rim Drive and Pinnacles Road) were surveyed at least once by foot in their entirety, including access roads and around piles of materials.



Figure 10. Surveying for nonnative plants along East Rim Drive. Photos by Carrie Wyler.

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 or chemical methods as per the park's Invasive Vegetation Management Plan (DOI NPS 2017). All plant parts capable of reproduction are bagged and disposed of in the trash compactor at park headquarters. Any new-to-CRLA nonnative plant species encountered are collected as voucher specimens for the park's herbarium. Additionally, nonnative 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

To date, 29 restoration sites have been identified for Phase II of the RDRR project, each with a unique revegetation prescription based on pre-disturbance conditions (Table 2). Identification of Phase II restoration sites was guided by construction plan sets (95% design phase) and did not include disturbed sites at Roundtop Quarry or areas affected by deep patch or edge stabilization treatments. It is likely the number of sites will increase as impacts from those treatments become more apparent. When Phase I of the Rim Drive Rehabilitation project was completed, the actual area disturbed was found to be greater than three times what was planned (Wylar et al. 2020). The planned area of disturbance for Phase II of this project is anticipated to affect 21.2 acres.

Seed Collection

Plant phenology was monitored during the field season through biweekly visits to collection sites, and then later in the season concurrently with seed collection. In 2022, seed collection for Phase II of the project commenced in early August and continued into late October (Figure 11). The peak seed collection for the bulk of plant species in most of the seed zones occurred from mid-August to late September (Table 3). Some plant species offered a long collection period due to multiple flowering episodes throughout the growing season. The 2022 growing season was notable for a late heavy snowfall in May and snowpack persisting until July 1st at park headquarters. This caused plant species to develop later than usual resulting in a delayed seed collection period.



Figure 11. Seed collection along East Rim Drive (left) and in a meadow (right) for the RDRR project. Photos by NPS staff.

Table 2. Example of a site documentation prescription form for the RDRR project.

Seed Zone: Dutton		ID: D24 (old site D17)	Planned site
Location: Dutton Ridge, WBP tree pullout, non-lake side, (station 644+ to 646+)			
Site Description: gravel pullout to obliterate			
Pre-Disturbance Site Information			
Plant Species	Common Name	Relative % Cover	
<i>Agoseris</i> sp.	Agoseris	2	
<i>Calyptridium umbellatum</i>	Pussypaws	3	
<i>Carex halliana</i>	Hall's sedge	33	
<i>Castilleja arachnoidea</i>	Cobwebby paintbrush	3	
<i>Ericameria greenei</i>	Greene's goldenbush	15	
<i>Eriogonum marifolium</i> var. <i>marifolium</i>	Marumleaf buckwheat	10	
Grasses (<i>Elymus elymoides</i> ssp. <i>elymoides</i> , <i>Eriocoma occidentalis</i>)	Common squirreltail, western needlegrass	15	
<i>Koenigia davisiae</i> var. <i>davisiae</i>	Davis' knotweed	5	
<i>Lupinus albicaulis</i> var. <i>shastensis</i>	Pine lupine	2	
<i>Lupinus lepidus</i> var. <i>lobbii</i>	Prostrate lupine	5	
<i>Phacelia hastata</i> var. <i>compacta</i>	Compact phacelia	3	
<i>Viola purpurea</i>	Goosefoot violet	2	
Other		2	
		Total Cover:	100%
Associated species: <i>Raillardella argentea</i> (silky raillardella), <i>Pinus albicaulis</i> (whitebark pine -- sensitive)			
UTM (Zone 10, NAD 83):	End: 0576025	End: 4749089	
Total Vegetative Cover: 65%		Elevation: 7,204 ft.	
Slope: low (-8 degrees)	Aspect: NW	Snowmelt out:	
Soil "hardness," presence of rocks: medium due to vehicle parking causing compaction			
General Soil description: pumice, sand, gravel			
Ameliorating microsite features: duff, conifer needles, small diameter branches, gravel, existing vegetation, fine organic debris			
Wind exposure: high	Canopy cover (overall): low-medium		
Area: projected: 1,754 ft ² actual:			
Comments: Whitebark pine clump at site			
Recorder: CW, SH		Date: 7/8/20	

Table 3. 2022 seed collection periods for priority collection species indicated by gray shading.

Species	JULY (late)	AUG (early)	AUG (mid)	AUG (late)	SEPT (early)	SEPT (mid)	SEPT (late)	OCT (early)	OCT (mid)	OCT (late)
<i>Calyptridium umbellatum</i>										
<i>Carex pachycarpa</i>										
<i>Drymocallis glandulosa</i> var. <i>reflexa</i>										
<i>Ericameria nauseosa</i> var. <i>speciosa</i>										
<i>Eriocoma occidentalis</i>										
<i>Eriogonum marifolium</i> var. <i>marifolium</i>										
<i>Holodiscus microphyllus</i> var. <i>glabrescens</i>										
<i>Juncus parryi</i>										
<i>Koenigia davisiae</i> var. <i>davisiae</i>										
<i>Lupinus lepidus</i> var. <i>lobbii</i> *										
<i>Penstemon</i> species										
<i>Phacelia hastata</i> var. <i>compacta</i>										

*Species with two flowering and seed production episodes in one season.

In 2022, Botany staff collected seed from species on the Phase II RDRR project’s species collection list; quantities are listed in Table 4. Seed collection efforts were focused on the Skell and Mt. Scott seed zones since those areas are scheduled to undergo construction first. Grasses and sedges produced abundant seed that was easy to collect, and thus comprised the bulk of the 2022 seed collection. Species that were collected in lower quantities this season include lupine (*Lupinus* sp.), pussypaws (*Calyptridium umbellatum*), and *Penstemon* species as predation from unknown insects and mammals significantly reduced the quantity and quality of available seed. However, these species do extremely well at establishing in disturbed areas from seed, and therefore are worth the extra effort to collect. Davis’ knotweed (*Koenigia davisiae* var. *davisiae*) continued to pose a challenge for seed collection and plant propagation efforts by seed. 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 attempts at propagating Davis' knotweed suggest root division/cuttings are viable means of propagation (Trindle and Flessner 2003).

Table 4. Seed collection quantities for 2022.

Seed Zone	Scientific Name	Common Name	Amount collected (grams) 2022
Skell	<i>Boechera horizontalis</i>	Crater Lake rockcress	13.1
	<i>Boechera</i> undescribed	Undescribed <i>Boechera</i>	2
	<i>Eriocoma occidentalis</i> *	Western needlegrass	165.3
	<i>Calyptridium umbellatum</i>	Pussypaws	1
	<i>Carex pachycarpa</i> *	Many-rib sedge	127.1
	<i>Drymocallis glandulosa</i> var. <i>reflexa</i>	Montana sticky cinquefoil	3
	<i>Ericameria nauseosa</i> var. <i>speciosa</i> *	Showy rabbitbrush	24.4
	<i>Eriogonum marifolium</i> var. <i>marifolium</i>	Marumleaf buckwheat	13
	<i>Eriogonum nudum</i> var. <i>nudum</i>	Barestem buckwheat	0
	<i>Hieracium horridum</i>	Shaggy hawkweed	5
	<i>Holodiscus microphyllus</i> var. <i>glaberscens</i> *	Bush ocean spray	77.7
	<i>Juncus parryi</i>	Parry's rush	0
	<i>Lupinus lepidus</i> var. <i>lobbii</i> *	Prostrate lupine	22.4
	<i>Oxyria digyna</i>	Alpine sorrel	0
	<i>Packera cana</i>	Woolly groundsel	0**
	<i>Penstemon davidsonii</i> var. <i>davidsonii</i>	Davidson's penstemon	20.7
	<i>Penstemon speciosus</i>	Royal penstemon	14.2
<i>Phacelia mutabilis</i> *	Changeable phacelia	46.7	
Mt. Scott	<i>Boechera</i> undescribed	Undescribed rockcress	0
	<i>Calyptridium umbellatum</i>	Pussypaws	0
	<i>Carex pachycarpa</i>	Many-rib sedge	0
	<i>Castilleja arachnoidea</i>	Cobwebby paintbrush	0
	<i>Dieteria canescens</i> var. <i>shastensis</i>	Rayless Shasta aster	0
	<i>Ericameria greenei</i> *	Greene's goldenbush	0
	<i>Eriocoma occidentalis</i> *	Western needlegrass	47.5
	<i>Eriogonum marifolium</i> var. <i>marifolium</i> *	Marumleaf buckwheat	50.9
	<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	Hairy Shasta buckwheat	8.4
	<i>Hieracium horridum</i>	Shaggy hawkweed	3
	<i>Hulsea nana</i>	Dwarf Hulsea	8
	<i>Juncus parryi</i> *	Parry's rush	38.3
	<i>Koenigia davisiae</i> var. <i>davisiae</i> *	Davis' knotweed	91.5
	<i>Lomatium martindalei</i>	Cascade desert parsley	9
	<i>Lupinus lepidus</i> var. <i>lobbii</i> *	Prostrate lupine	37
<i>Phacelia mutabilis</i> *	Changeable phacelia	0	
<i>Raillardella argentea</i>	Silky raillardella	0	
Kerr	<i>Arnica longifolia</i>	Longleaf arnica	0
	<i>Boechera howellii</i>	Howell's flatseed rockcress	0
	<i>Carex</i> species mix*	Sedge species mix	19
	<i>Drymocallis glandulosa</i> var. <i>reflexa</i> *	Montana sticky cinquefoil	54.6
	<i>Elymus glaucus</i> ssp. <i>glaucus</i>	Blue wildrye	10
	<i>Eriocoma occidentalis</i> *	Western needlegrass	1

Seed Zone	Scientific Name	Common Name	Amount collected (grams) 2022
	<i>Eriogonum nudum</i> var. <i>nudum</i>	Barestem buckwheat	0
	<i>Hackelia micrantha</i>	Blue stickseed	11.7
	<i>Lomatium martindalei</i>	Cascade desert parsley	0
	<i>Phacelia mutabilis</i> *	Changeable phacelia	2
	<i>Raillardella argentea</i>	Silky raillardella	0
	<i>Ribes erythrocarpum</i>	Crater Lake currant	0
	<i>Ribes lacustre</i>	Swamp currant	0
Dutton	<i>Castilleja arachnoidea</i>	Cobwebby paintbrush	0
	<i>Chaenactis alpina</i>	Alpine chaenactis	5
	<i>Ericameria greenei</i> *	Greene's goldenbush	0
	<i>Eriocoma occidentalis</i> *	Western needlegrass	0
	<i>Eriogonum marifolium</i> var. <i>marifolium</i> *	Marumleaf buckwheat	139.9
	<i>Eucephalus ledophyllus</i>	Cascade aster	0
	<i>Koenigia davisiae</i> var. <i>davisiae</i> *	Davis' knotweed	0
	<i>Lupinus lepidus</i> var. <i>lobbii</i> *	Prostrate lupine	0
	<i>Phacelia mutabilis</i> *	Changeable phacelia	0
	<i>Raillardella argentea</i>	Silky raillardella	0
Vidae	<i>Arnica viscosa</i>	Shasta arnica	7.9
	<i>Elymus glaucus</i> ssp. <i>glaucus</i>	Blue wildrye	0
	<i>Eriocoma occidentalis</i> *	Western needlegrass	0
ALL		TOTAL	1,080.3

*Priority collection species

**Seed destroyed by insect predation while drying

To augment the amount of plant materials available for revegetation in both Phase I & II of this project, the seed increase services of the Meeker Plant Materials Center (PMC) were utilized. The Meeker PMC maintained two seed increase fields for California brome (*Bromus sitchensis* var. *carinatus*) and common squirreltail (*Elymus elymoides* ssp. *elymoides*) sown from CRLA seed. The 2021 growing season marked the last year of seed production for this effort. The Meeker PMC will continue to store seed through October 2023; after that date the seed will be sent to the DGRC for storage. This seed will be available for use in revegetation efforts for the life of this phase of the project as needed. Seed production totals are displayed in Table 5.

Table 5. Production totals from seed increase efforts by the Meeker PMC. CBS = clean bulk seed.

Plant Species	2017 CBS (lbs.)	2018 CBS (lbs.)	2019 CBS (lbs.)	2020 CBS (lbs.)	2021 CBS (lbs.)	Amount CBS (lbs.) Received at CRLA in 2019	Amount CBS (lbs.) Available for Phase II
California brome	1.8	74.9	246.0	61.0	29.6	8.6	404.7
Squirreltail	9.6	123.5	218.5	21.0	53.0	20	404.6

*In 2017, the Meeker PMC's crop of California brome was stunted and produced very little seed (< 1 lb.).

Plant Care and Nursery Work

After the snow melted in 2022, overwintered plants were assessed and inventoried. Plants without any green growth or with rotted roots were discarded. Plants with well-developed roots were transplanted into larger containers and plants with detritus, moss, liverwort, or volunteer plants were cleaned (Figure 12).

Most of the grass species in the nursery became infected with a rust in the fall of 2020 and 2021. The infected areas were trimmed and treated with a baking soda, soap, oil, and water mixture in 2020. This helped reduce the severity and extent of the rust infestation but not eliminate it. In 2021, infected plants were treated with a sulfur water mixture. This also helped to reduce but not eliminate the infestation. Plants that were still infected with rust in August 2021 were disposed of in the park's trash compactor. Disposing of the infected plants was necessary to eradicate the rust infestation. In 2022, plants were regularly assessed for recurring infection. Only one rack of plants was found to be infected at an early stage and was immediately disposed of. Biweekly inspections of containerized grasses will be required on annual basis to ensure that future infestations will be caught during early stages of infection.

Detailed reports of daily nursery activities are on file in the Botany office in the Nursery Activities binder. Over the fall and winter of 2020-2021 1,134 plants were propagated by CRLA and the DGRC for the Phase II RDRR project as construction was planned to commence during summer 2022 (Table 6). These plants need multiple years of growth to become large enough to be planted in heavily disturbed areas. In 2022, all plants that were found to have no growth were disposed of and all that were root bound were transplanted into larger pots. Current numbers of containerized plants for this project are listed in Table 6.



Figure 12. Plant care at the park's nursery. Photos by Carrie Wyler.

Table 6. Plant propagation quantities for Phase II of the RDRR project as of fall 2022.

Seed Zone	Scientific Name	Restoration Site	Quantity of Plants as of fall 2022
Skell	<i>Penstemon davidsonii</i> var. <i>davidsonii</i>	For seed increase beds	195
	<i>Ribes viscosissimum</i>	Grotto Cove and Skell Head islands	36
Mt. Scott	<i>Alnus alnobetula</i> ssp. <i>sinuata</i>	Pumice Castle Overlook	20
Kerr	<i>Alnus alnobetula</i> ssp. <i>sinuata</i>	Pinnacles Junction	20
	<i>Ribes</i> sp.	Phantom Ship Overlook islands and Pinnacles Junction	74
TOTAL			345

Special Status Plant Management

During the 2020 season, Phase II of the RDRR project was surveyed for special status plant species. Thirteen rare plant populations were encountered in the project area that will need protections during construction. Some of these rare plant populations will experience unavoidable impacts due to their occurrence in deep patch and edge stabilization treatment areas, within the road shoulder, in cracks between rock walls and pavement, or otherwise in the path of impact (Figure 13).

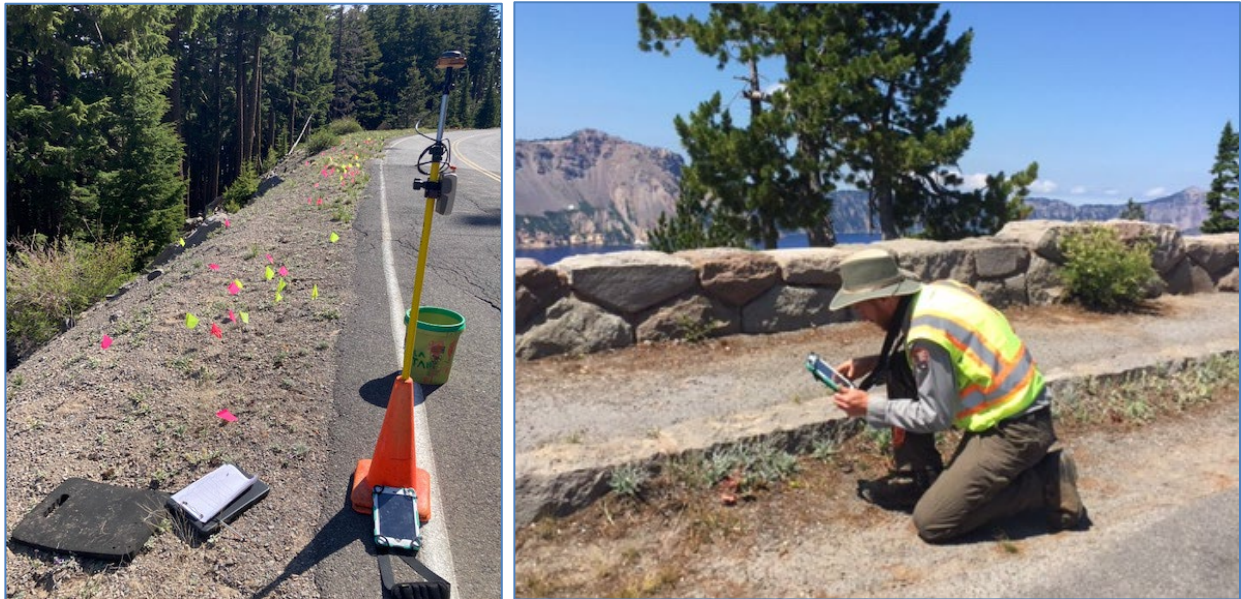


Figure 13. Some rare plants will experience unavoidable road construction impacts such as Crater Lake rockcress growing close to the road edge (left) and shaggy hawkweed growing in cracks between pavement and stone curbing (right). Photos by Carrie Wyler.

In these cases, rare plants are salvaged ahead of construction and held over at the Ball Diamond nursery until they can be replanted. In 2021 and 2022, 766 rare plants were salvaged from six different sites on East Rim Drive (Figure 14). Quantities of salvaged plants are listed in Table 7.

Additional rare plant salvage may occur in future field seasons as construction progresses. Seed was also collected from rare plant species in the immediate path of construction impacts. Quantities of seed collected from rare plants in Phase II disturbance areas are displayed in Table 8. Spatial and population rare plant data are housed on the Botany file server.



Figure 14. Salvaging pumice moonwort (left) and Crater Lake rockcress (middle) from East Rim Drive. Crater Lake rockcress being transplanted into a 1-gallon pot for hold over until construction is completed (right). Photos by Carrie Wyler.

Table 7. Quantities of rare plants salvaged along East Rim Drive in 2021 and 2022.

Seed Zone	Plant species	2021	2022
Skell (site 1)	<i>Boechea horizontalis</i> (Crater Lake rockcress)	135	0
Skell	<i>Boechea</i> undescribed	90	55
Skell	<i>Botrychium pumicola</i> (pumice moonwort)	10	6
Skell (site 2)	<i>Boechea horizontalis</i> (Crater Lake rockcress)	0	404
Skell	<i>Hieracium horridum</i> (shaggy hawkweed)	0	66
TOTAL		235	531

Table 8. Rare plant seed collected in 2021 and 2022 from the RDRR Phase II project area.

Seed Zone	Plant species	Seed collected (g) 2021	Seed collected (g) 2022
Vidae	<i>Arnica viscosa</i> (Shasta arnica)	9	7.9
Mt. Scott	<i>Boechea</i> undescribed	1	0
Mt. Scott	<i>Hieracium horridum</i> (shaggy hawkweed)	5	3
Skell	<i>Boechea</i> undescribed	0	2
Skell	<i>Boechea horizontalis</i> (Crater Lake rockcress)	9	6.1
Skell	<i>Hieracium horridum</i> (shaggy hawkweed)	1	5
TOTAL		25	24

Invasive Vegetation Management

A total of 7,441 invasive plants were treated in the project and staging areas during the 2022 field season. A new population of red sorrel (*Rumex acetosella*) was discovered in a meadow near Skell Head overlook in 2021. Chemical treatment of the population drastically reduced the infestation; it was retreated in 2022. Also, in 2021 a new-to-CRLA invasive plant species, hairy bittercress (*Cardamine hirsuta*), was discovered at the park's Ball Diamond nursery. This plant is believed to have been brought in on a shipment of plants and has been targeted for eradication so that it does not spread beyond the nursery area. In 2022, another new-to-CRLA invasive plant species, creeping yellow wood sorrel (*Oxalis corniculata*), was found growing in nursery stock and believed to have been introduced to the park from another shipment of plants. To assist with containing all introduced invasive species from partner nursery plant shipments, staff installed weed barrier cloth in the park's native plant nursery (Figure 15).

Two other new-to-CRLA invasive plant species were found in the RDRR project area during the 2022 field season. Jim Hill mustard (*Sisymbrium altissimum*) was found in the parking lot island at Skell Head overlook and bullhead (*Tribulus terrestris*) was found in the parking lot behind the Rim Village Café and Gifts building. The number of invasive plants treated over the 2019 to 2022 field seasons within the RDRR project area is displayed in Table 9. Maps of invasive plant locations for 2022 are displayed in five zones: East Rim Drive, Ball Diamond, Pole Bridge Creek Quarry, Rim Village Lodge, and Rim Village Café and Gifts building (Figures 17-21).

Large populations of oval-leaf knotweed (*Polygonum aviculare* ssp. *depressum*), red sorrel, and red sand-spurrey (*Spergularia rubra*) at Rim Village were treated as time allowed (Figure 16). The large population of red sorrel by the Crater Lake Lodge has been subject to a large control effort annually since 2013, often using volunteer groups. This site was first treated with herbicide in the fall of 2017 and has been treated annually since. Red sorrel abundance was greatly reduced in 2018 and 2019, which may be attributable to the effectiveness of chemical treatment. In 2020 two new population areas were discovered which led to an increase in numbers from 2019, but numbers were again diminished during the 2021 and 2022 field seasons. Oval-leaf knotweed is another species that continues to increase greatly in number for unknown reasons, especially around the Crater Lake Lodge and in parking lot cracks. This is another difficult species to treat by manual means due to its deep root systems and tendency to occur in pavement cracks and crevices.



Figure 15. Installing weed barrier cloth at the park's native plant nursery. Photos by Carrie Wyler.

Table 9. Invasive plant abundance (number of plants) within the RDRR project area from 2018--2022.

Region	Invasive Plant Species	2019 Abundance	2020 Abundance	2021 Abundance	2022 Abundance
Pole Bridge Creek Quarry	Bitter winter cress (<i>Barbarea vulgaris</i>)	95	4	1	0
	Common dandelion (<i>Taraxacum officinale</i>)	0	13	13	1
	Common St. John's wort (<i>Hypericum perforatum</i>)	0	8	0	2
	Erect cinquefoil (<i>Potentilla recta</i>)	0	20	0	88
East Rim Drive	Redtop (<i>Agrostis gigantea</i>)	0	0	0	3
	Bitter winter cress (<i>Barbarea vulgaris</i>)	0	0	7	1
	Canola (<i>Brassica napus</i>)	0	2	0	0
	Smooth brome (<i>Bromus inermis</i>)	0	500	0	0
	Common St. John's wort (<i>Hypericum perforatum</i>)	0	6	4	0
	Ox-eye daisy (<i>Leucanthemum vulgare</i>)	0	0	0	1
	Canada bluegrass (<i>Poa compressa</i>)	200	0	0	0
	Kentucky bluegrass (<i>Poa pratensis</i>)	0	38	0	0
	Red sorrel (<i>Rumex acetosella</i>)	80	0	4,000	141
	Jim Hill mustard (<i>Sisymbrium altissimum</i>)	0	0	0	6
	Common dandelion (<i>Taraxacum officinale</i>)	585	277	330	60
West Rim Drive	Red sorrel (<i>Rumex acetosella</i>)	12	0	0	0
Ball Diamond	Hairy bittercress (<i>Cardamine hirsuta</i>)	0	0	75	50
	Hairy cat's-ear (<i>Hypochaeris radicata</i>)	0	0	1	0
	Creeping yellow wood sorrel (<i>Oxalis corniculata</i>)	0	0	0	50
	Red sand-spurrey (<i>Spergularia rubra</i>)	**	50	104	442
Rim Village	Redtop (<i>Agrostis gigantea</i>)	0	0	0	30
	Bitter winter cress (<i>Barbarea vulgaris</i>)	294	178	9	21
	Orchard grass (<i>Dactylis glomerata</i>)	0	0	1	0

Region	Invasive Plant Species	2019 Abundance	2020 Abundance	2021 Abundance	2022 Abundance
	Field cress (<i>Lepidium campestre</i>)	1	0	0	0
	Yellow sweetclover (<i>Melilotus officinalis</i>)	0	10	0	0
	Buckhorn plantain (<i>Plantago lanceolata</i>)	3	2	0	0
	Common plantain (<i>Plantago major</i>)	3	0	0	0
	Annual bluegrass (<i>Poa annua</i>)	0	75	270	0
	Oval-leaf knotweed (<i>Polygonum aviculare</i> ssp. <i>depressum</i>)	3,930	1,730	4,805	3,239
	Red sorrel (<i>Rumex acetosella</i>)	1,719	2,942	1,366	736
	Wood groundsel (<i>Senecio sylvaticus</i>)	0	0	6	0
	Red sand-spurrey (<i>Spergularia rubra</i>)	69,174	28,050	20,140	2,549
	Common dandelion (<i>Taraxacum officinale</i>)	69	27	80	20
	Yellow salsify (<i>Tragopogon dubius</i>)	0	0	1	0
	Bullhead (<i>Tribulus terrestris</i>)	0	0	0	1
	Dutch clover (<i>Trifolium repens</i>)	128	15	55	0
	Total	76,840	42,156	31,268	7,441

**No data available.



Figure 16. Chemically treating invasive species (left, right), collecting data on IVM treatments (middle). Photos by Carrie Wyler.

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Ball Diamond Staging Area - Invasive Vegetation Populations 2022



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30 15 0 30 Meters

Coordinate System:
NAD 1983 UTM Zone 10N



Date: 11/2/2022

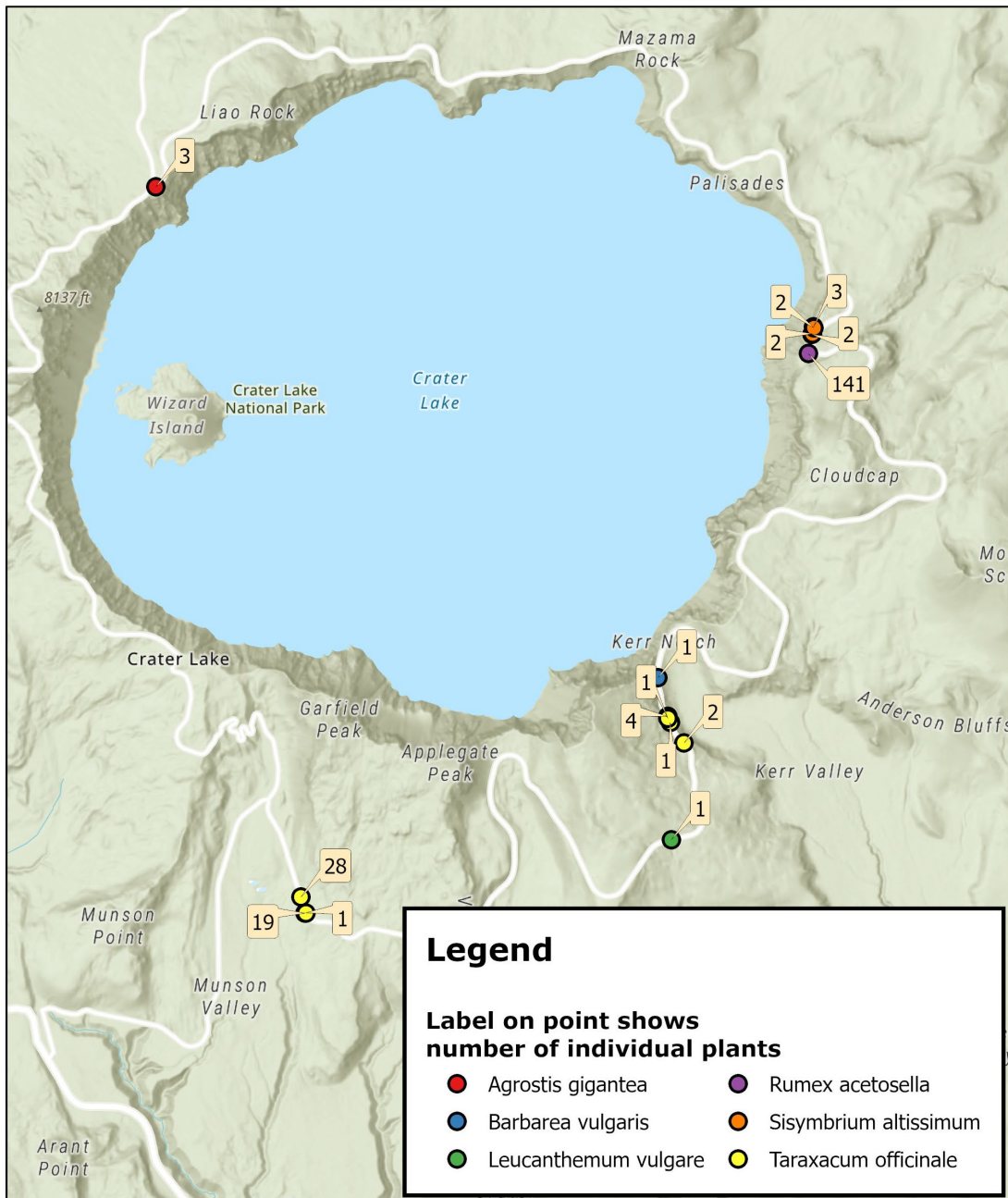
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Figure 17. Invasive plant populations treated at the park's Ball Diamond. Map by Scott Heisler.

Crater Lake National Park

East Rim Drive - Invasive Vegetation Populations 2022

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Coordinate System:
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Figure 18. Invasive plant populations treated along Rim Drive. Map by Scott Heisler.

Crater Lake National Park

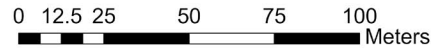
Pole Bridge Quarry - Invasive Vegetation Populations 2022

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Date: 11/2/2022



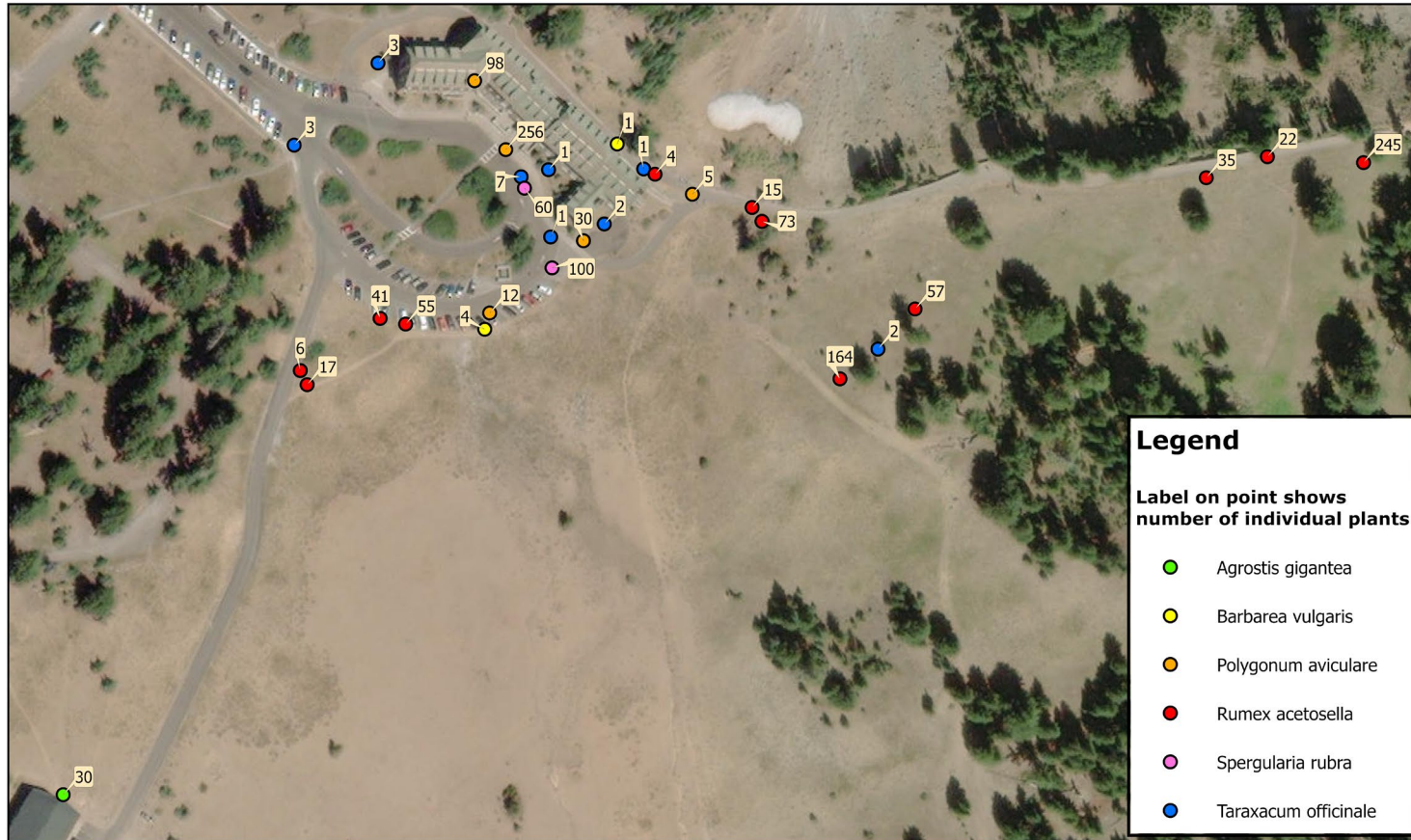
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Figure 19. Invasive plant populations treated at the Pole Bridge Creek Quarry staging area. Map by Scott Heisler.

Crater Lake National Park

Crater Lake Lodge - Invasive Vegetation Populations 2022

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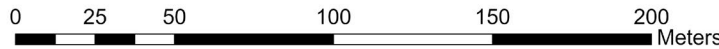
Legend

Label on point shows number of individual plants

- Agrostis gigantea
- Barbarea vulgaris
- Polygonum aviculare
- Rumex acetosella
- Spargularia rubra
- Taraxacum officinale

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Coordinate System:
NAD 1983 UTM Zone 10N
Date: 11/2/2022



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Figure 20. Invasive plant populations for the Rim Village Lodge area. Map by Scott Heisler.

Crater Lake National Park

Rim Village - Invasive Vegetation Populations 2022

National Park Service
U.S. Department of the Interior



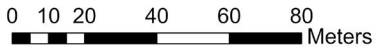
Legend

Label on point shows number of individual plants

- Barbarea vulgaris
- Polygonum aviculare
- Rumex acetosella
- Spargularia rubra
- Tribulus terrestris

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Coordinate System:
NAD 1983 UTM Zone 10N
Date: 11/2/2022



Document Path: R:\GIS\UserMaps\034_RDRR_Phase2\IVM\Projects\RDRR2_IVM_2022\RDRR2_IVM_2022.aprx

Figure 21. Invasive plant populations around the Rim Village Café and Gifts area. Map by Scott Heisler.

Discussion

During the 2022 season preparation for restoration work was conducted. The project area was surveyed for nonnative plants, seed was collected and cleaned, previously propagated plants were cared for, rare plants were salvaged, and sites were documented. Two struggling sites from Phase 1 of the RDRR project located at the Cleetwood Cove parking lot had new plants added, rock circles expanded, and signage and fencing installed (fencing needs to be installed each spring and removed each fall due to snowpack constraints).

Recommendations and needs for RDRR work in the 2023 field season include:

- All plants that overwintered need to be assessed for status and health. Root-bound plants will need to be transplanted into larger containers or divided as soon as practical after the snow melts. Plants will need fertilization to assist with survival and growth. Care should be taken to not expose newly transplanted plants to water, light, or temperature shock. All containerized plants should be checked for moss, liverwort growth, and weeds and they should be removed if present.
- 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. The entire project area needs to be thoroughly surveyed for invasive plants at least twice throughout the 2023 field season.
- All revegetation sites for Phase II of the RDRR project will need to be mapped with a high-resolution GPS receiver. Mapping efforts made previously were found to be insufficient for site documentation.
- All site prescriptions in the revegetation plan should be reviewed, and any missing data should be collected.
- Seed collection will need to continue each season, with priority given to the seed zones that will experience the earliest construction impacts. Seed should be collected from sensitive plant populations in the path of construction each year until they are destroyed. If time allows, seed can be collected in other zones, targeting species that need longer time to establish in a nursery setting and species that produce low quantities of or difficult-to-collect seed.
- Propagation will need to be conducted for the first construction zone (Skell) in the fall of 2023 so plants are available for planting in 2024.
- 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 should be used to 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.

- Restoration prescriptions will need to be developed for Roundtop Quarry. Its slopes were mechanically recontoured by the Phase I contractors leaving the disturbed areas completely devoid of vegetation (Figure 22). Once the park has determined the desired footprint for future use of this area, disturbed areas outside this footprint need to be revegetated and restored. Some of the seed produced by the Meeker PMC can be used at this site. Seed will need to be raked in with park compost and native debris distributed. The area will need to be mapped, documented, and monitored in Phase II for restoration progress and surveyed diligently for invasive plant species.



Figure 22. Slope disturbed at Roundtop Quarry by slash piling and ground disturbance in 2015 (left); same slope after removing slash and recontouring in 2018 (right). Photos by Jen Hooke.

- During 2019, 2020, and 2021 large rock rings were made around grouped plantings at the Cleetwood Cove parking lot, Glacial Scratches pullout areas, and Watchman Overlook. This technique has been deemed successful in deterring trampling if larger rocks are used and will be used in future restoration areas. Some areas may need more obvious exclusion methods such as fencing and signage. These sites need to be checked multiple times throughout the season as rock circles and fencing need maintenance.
- Restoration work has been ongoing at site NEERD3, which is the Cleetwood Cove parking lot. Construction work at the comfort stations and ticket booth sites was not completed until the fall of 2019. Landscaping islands and beds in the parking lot have been revegetated, but these areas are heavily trampled by visitors which presents challenges to restoration. These areas will need to be assessed yearly for traffic patterns and trampling and filled in with plants as problem areas arise. Additional barriers (fencing) may be needed to protect the newly established vegetation. Installation of fencing was not possible in the front of the parking lot due to a buried gas line's unknown location. To protect young vegetation until it is large enough to be visible by parking lot users, plants were placed in groups and circled with large rocks to form a barrier (Figure 23). Each year additional plants will be added, and the rock circles expanded.

- The back of the Cleetwood Cove parking lot will be worked on during Phase II of the RDRR project. The area presently is not big enough for large recreational vehicles to pass through and their back wheels often jump the curb and damage this revegetation site (Figure 23). This area has been sparsely planted in areas that would not be impacted by vehicle traffic. After construction work is completed, more plants should be added.



Figure 23. Plantings in groups with rock borders to mitigate trampling in heavily trafficked Cleetwood Cove parking lot areas (left). The area at the back of the Cleetwood Cove parking lot needs to be adjusted to allow for RVs to drive around the comfort station without damaging the landscaping island (right). Photos by Carrie Wyler.

- Site NEERD 3.1 is the eastern embankment of the Cleetwood Cove parking lot and will continue to need maintenance in future years. It has a steep slope of pumice soil that is continuously eroding and hindering restoration efforts. This area was planted with Hall’s sedge in 2021 and 2022 after discovering that rhizomatous plants are the only plants that successfully establish themselves on the steep embankment (Figure 24). The area will need assessment after the 2022 plantings. If the plantings continue to be successful, more plants will need to be installed on the embankment; more Hall’s sedge may be needed for this endeavor as it does not propagate well from seed.



Figure 24. The steep slope of the embankment in the Cleetwood Cove parking lot with Hall's sedge taking hold (left). Planting more Hall's sedge on the embankment in 2022 (right). Photos by Carrie Wyler.

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Appendix A

CRLA RDRR Project Phase II: Master Revegetation List from 95% Plan Set.

ID#	Station	Page(s)	Type	Length (ft)	Seed Zone	Location	Completion Date (est.)
1	037+95 to 048+55	D.4-5	Deep Patch 3 Full	1,060	Skell	Before Mazama Rocks Trailhead	10/23
2	072+95 to 074+90	D.6	Deep Patch 2 Full	195	Skell	After Mazama Rocks trailhead	10/23
3	077+95 to 078+35	D.7	Deep Patch 2 Full	40	Skell	Before Palisades Overlook	10/23
4	091+85 to 096+00	D.7-8	Deep Patch 1 Full	415	Skell	After Palisades Overlook	10/23
5	096+00 to 100+05	D.8	Deep Patch 2 Full	405	Skell	Before and at Palisades Point	10/23
6	102+80 to 103+70	D.8	Deep Patch 1 Full	90	Skell	After Palisades point #1	10/23
7	106+80 to 109+25	D.9	Deep Patch 1 Right	245	Skell	After Palisades	10/23
8	113+80 to 118+00	D.9	Deep Patch 1 Full	420	Skell	After Palisades	10/23
9	127+80 to 130+40	D.10	Edge Stabilization 2 Left	260	Skell	After Palisades	10/23
10	139+65 to 140+80	D.11	Deep Patch 1 Left	115	Skell	Before Roundtop	10/23
11	152+05 to 152+70	D.12	Deep Patch 1 Left	65	Skell	After Roundtop	10/23
12	158+20 to 160+05	D.12	Deep Patch 1 Left	185	Skell	After Roundtop	10/23
13	165+20 to 173+70	D.13	Deep Patch 1 Full	850	Skell	Before Grotto	10/23
14	173+70 to 176+00	D.13	Deep Patch 2 Left	230	Skell	Before Grotto	10/23
15	201+80 to 202+80	D.15	Deep Patch 1 Left	100	Skell	Before Grotto	10/23
16	216+00 to 216+70	D.16	Deep Patch 1 Full	70	Skell	Btwn Grotto & Skell	10/23
17	223+10 to 223+80	D.17	Deep Patch 1 Full	70	Skell	Before Skell Head	10/23
18	225+30 to 227+30	D.17	Deep Patch 1 Left	200	Skell	Skell Head – BOEHOR population	10/24
19	238+20 to 241+65	D.18	Deep Patch 1 Left	345	Skell	After Skell Head	10/24
20	243+10 to 243+60	D.18	Edge Stabilization 2 Left	50	Skell	After Skell Head	10/24

ID#	Station	Page(s)	Type	Length (ft)	Seed Zone	Location	Completion Date (est.)
21	244+00 to 249+00	D.18	Deep Patch 3 Full	500	Skell	Bear Creek-BOEHOR population	10/24
22	253+80 to 255+90	D.19	Deep Patch 2 Full	210	Scott	After Bear Creek	10/24
23	257+00 to 259+30	D.19	Deep Patch 1 Left	230	Scott	After Bear Creek	10/24
24	273+20 to 274+00	D.20	Deep Patch 1 Left	80	Scott	Before Scott Bluffs	10/24
25	283+55 to 284+00	D.21	Deep Patch 2 Full	45	Scott	Before Scott Bluffs	10/24
26	287+15 to 288+10	D.21	Edge Stabilization 2 Left	95	Scott	Scott Bluffs-HIEHOR 2	10/24
27	298+80 to 300+50	D.22	Edge Stabilization 1 Left	170	Scott	Scott Bluffs-HIEHOR 1	10/24
28	301+30 to 301+90	D.22	Deep Patch 2 Full	60	Scott	Scott Bluffs	10/24
29	311+60 to 312+95	D.23	Deep Patch 3 Full	135	Scott	Scott Bluffs BOEUND	10/24
30	332+65 to 333+35	D.24	Edge Stabilization 1 Left	70	Scott	Before WBP picnic area	10/24
31	333+35 to 334+50	D.24	Deep Patch 1 Left	115	Scott	Before WBP picnic area	10/24
32	339+58 to 341+15	D.25	Edge Stabilization 1 Right	157	Scott	Before WBP picnic area	10/24
33	342+80 to 345+20	D.25	Edge Stabilization 1 Right	240	Scott	After WBP picnic area	10/24
34	350+85 to 352+15	D.25	Edge Stabilization 2 Left	130	Scott	After Mt. Scott trailhead	10/24
35	351+18 to 351+85	D.25	Edge Stabilization 2 Right	67	Scott	After Mt. Scott trailhead	10/24
36	353+00 to 353+58	D.25-26	Edge Stabilization 1 Left	58	Scott	After Mt. Scott trailhead	10/24
37	354+55 to 394+20	D.26-28	Deep Patch 1 Full	3,965	Scott	Before, past, after Cloudcap Spur road	10/24
38	398+70 to 401+85	D.29	Deep Patch 2 Left	315	Scott	Before Pumice Castle	10/24
39	403+10 to 407+80	D.29	Deep Patch 1 Full	470	Scott	Before Pumice Castle	10/24
40	432+00 to 457+95	D.31-33	Deep Patch 1 Full	2,595	Scott	Before Sentinel Rock to after Reflection point	10/24
41	457+95 to 461+60	D.33	Deep Patch 1 w/Shoulder Stabilization	365	Scott	After Reflection Point	10/25
42	461+60 to 462+10	D.33	Deep Patch 1 Full	50	Scott	After Reflection Point	10/25
43	466+00 to 467+80	D.33	Deep Patch 1 Full	180	Scott	After Reflection Point	10/25
44	467+60 to 470+70	D.33-34	Deep Patch 1 w/Shoulder Stabilization	290	Scott	After Reflection Point	10/25
45	470+70 to 474+70	D.34	Deep Patch 1 Full	400	Scott ?	After Reflection Point	10/25
46	506+70 to 508+30	D.36	Deep Patch 3 Full	160	Kerr	Before Phantom Ship	10/25
47	512+20 to 513+55	D.36-37	Deep Patch 1 Right	135	Kerr	Before Phantom Ship	10/25

ID#	Station	Page(s)	Type	Length (ft)	Seed Zone	Location	Completion Date (est.)
48	517+50 to 520+40	D.37	Deep Patch 2 Full	290	Kerr	Before Phantom Ship	10/25
49	532+80 to 551+30	D.38-39	Deep Patch 1 Full	2,750	Kerr	Kerr notch	10/25
50	562+75 to 568+00	D.40	Deep Patch 1 Full	525	Kerr	After Pinnacles Road	10/25
51	597+75 to 601+40	D.42-43	Deep Patch 1 Full	365	Kerr	Before Upper Dutton Cliffs	10/25
52	603+85 to 607+25	D.43	Deep Patch 1 Full	340	Kerr	Upper Dutton Cliffs	10/25
53	611+95 to 613+10	D.43	Deep Patch 1 Left	115	Kerr ?	After Upper Dutton Cliffs	10/25
54	629+60 to 629+80	D.45	Deep Patch 1 Left	20	Dutton	Before DU01, Dutton Ridge	10/25
55	636+00 to 641+00	D.45	Edge Stabilization 2 Left	500	Dutton	Before DU01, Dutton Ridge	10/25
56	703+10 to 704+60	D.50	Deep Patch 1 Left	150	Dutton ?	After Klamath Marsh Overlook	10/25
57	770+50 to 771+00	D.54	Deep Patch 1 Full	50	Vidae	After Sun Notch	10/26
58	776+20 to 777+23	D.55	Deep Patch 1 Left	103	Vidae	After Sun Notch	10/26
59	783+60 to 784+90	D.55	Deep Patch 1 Full	130	Vidae	After Sun Notch	10/26
60	786+30 to 787+60	D.55	Deep Patch 1 Right	130	Vidae	After Sun Notch	10/26
61	810+40 to 816+30	D.57	Deep Patch 1 Left	590	Vidae	Before Vidae Falls	10/26
62	818+15 to 820+75	D.58	Deep Patch 2 Left	260	Vidae	Before Vidae Falls	10/26
63	822+20 to 823+65	D.58	Deep Patch 3 Full	145	Vidae	Before Vidae Falls	10/26
64	823+65 to 825+75	D.58	Deep Patch 1 Full	210	Vidae	Before Vidae Falls	10/26
65	839+70 to 842+10	D.59	Deep Patch 1 Full	240	Vidae	After Vidae Falls	10/26
66	842+10 to 843+40	D.59	Deep Patch 2 Full	130	Vidae	After Vidae Falls	10/26
67	843+40 to 844+60	D.59	Deep Patch 2 Left	120	Vidae	After Vidae Falls	10/26
68	858+50 to 861+00	D.60-61	Deep Patch 1 Full	250	Vidae	After Vidae Falls	10/26
69	889+40 to 892+30	D.63	Edge Stabilization 1 Left	290	Vidae	After Vidae Falls	10/26
70	892+80 to 894+20	D.63	Edge Stabilization 2 Left	140	Vidae	After Vidae Falls	10/26
71	904+10 to 905+90	D.64	Edge Stabilization 1 Right	180	Vidae	After Vidae Falls	10/26
72	904+90 to 905+90	D.64	Edge Stabilization 1 Left	100	Vidae	After Vidae Falls	10/26

ID#	Station	Page(s)	Type	Length (ft)	Seed Zone	Location	Completion Date (est.)
73	928+27 to 929+80	D.65	Deep Patch 1 Full	153	Vidae	Between Vidae Falls and Castle Crest	10/26
74	936+55 to 937+50	D.66	Deep Patch 1 Full	95	Vidae	Before Castle Crest	10/26
75	944+70 to 964+20	D.66- D.68	Deep Patch 1 Full	1,950	Vidae	Before Castle Crest	10/26
76	971+10 to 973+20	D.68	Deep Patch 1 Full	210	Vidae	Castle Crest	10/26
77	APPR01 26+80 to 27+80	E.3	Edge Stabilization 2 Right	100	Scott	Cloudcap Spur Road	10/24
78	APPR01 30+40 to 31+50	E.3	Edge Stabilization 1 Right	110	Scott	Cloudcap Spur Road	10/24
79	APPR01 32+45 to 32+80	E.3	Edge Stabilization 1 Right	35	Scott	Cloudcap Spur Road	10/24
80	APPR01 44+50 to 46+10	E.4	Deep Patch 1 Full	160	Scott	Cloudcap Spur Road	10/24
81	APPR01 47+80 to 49+10	E.4	Edge Stabilization 1 Right	130	Scott	Cloudcap Spur Road	10/24
82	APPR01 50+00 to 50+70	E.4	Edge Stabilization 1 Right	70	Scott	Cloudcap Spur Road	10/24

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April 2023

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