



Cleetwood Cove Rock Scaling Revegetation Project

2020 Annual Report





ON THIS PAGE

View of the Cleetwood Cove trail and failing cribbing retaining wall.

Photo by Carrie Wyler.

ON THE COVER

Sign warning of rockfall hazard near the bottom of the Cleetwood Cove trail.

Photo by Carrie Wyler.

Cleetwood Cove Rock Scaling Revegetation Project

2020 Annual Report

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

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

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

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Contents

	Page
Figures.....	iv
Tables	iv
Abstract	v
Acknowledgments.....	vi
Introduction	1
Methods.....	4
Revegetation	4
Site Prescriptions	4
Native Seed Collection and Processing	5
Plant Propagation.....	6
Invasive Vegetation Management	7
Results.....	7
Revegetation	7
Site Prescriptions	7
Native Seed Collection and Processing	10
Plant Propagation.....	10
Invasive Vegetation Management	11
Discussion	11
Literature Cited	13

Figures

	Page
Figure 1. The Cleetwood Cove trail location in Crater Lake National Park. Distinct rock scaling zones to occur in shaded areas with patterns denoting the three distinct rock scaling zones..	2
Figure 2. Failing cribbing and rock retaining wall; unstable, rocky pumice soils on the Cleetwood Cove trail..	3
Figure 3. View of Crater Lake’s shoreline and failed dock and bulkhead.....	3
Figure 4. Planned rockfall mitigation and scaling areas on the Cleetwood Cove trail..	4
Figure 5. Forested area at the top of the trail; open shrubland with isolated trees present on the bottom half of the Cleetwood Cove trail.....	5
Figure 6. Seeding containers with sticky currant seed. Propagated pots with rodent-exclusion screens overwintered for cold stratification.....	6
Figure 7. Surveying for invasive plants along the Cleetwood Cove trail.	7
Figure 8. Seed drying facility in the Stall 9 garage.....	10

Tables

	Page
Table 1. 2020 plant phenology (month/day) for the Cleetwood Cove trail area.....	6
Table 2. Revegetation prescription for the Cleetwood Cove trail project.....	8
Table 3. Second prescription for the Cleetwood Cove trail project.	9
Table 4. Amount of seed collected by plant species in 2020.	10
Table 5. Number of seeded pots for plant propagation in 2020.....	11

Abstract

Crater Lake National Park's (CRLA) popular Cleetwood Cove trail provides the only legal public access to the shoreline of Crater Lake. In 2020, preliminary construction activities commenced to mitigate rockfall risk on the unstable slope the trail traverses. The Botany program at CRLA has been tasked with revegetation and restoration work in areas disturbed by rock scaling and trail stabilization efforts. Revegetation work completed on this project in 2020 included planning, collecting plant materials, and invasive vegetation management. These efforts resulted in completion of revegetation prescriptions for the project area; collection of seed and cuttings from 11 plant species; propagation of approximately 1,200 plants; and surveying for invasive plant species. Revegetation work planned for the 2021 season includes expanded seed collection efforts, continued propagation and care of propagated plants, and continued surveys for invasive plant species.

Acknowledgments

This project benefited from collaboration with the Crater Lake National Park Maintenance division; the assistance of Kirsten Hardin and Andrew Hoeg is greatly appreciated. Funding for this project was provided by the Federal Highway Administration Western Federal Lands Division. Members of the Botany staff assisted with seed collection and plant propagation efforts, including Hamilton Hasty, Eleanor Roeder, Shaina Nicassio, and Shane Palmer. The U.S. Forest Service Dorena Genetic Resource Center assisted with seed cleaning and plant propagation.

Introduction

Crater Lake National Park's (CRLA) Cleetwood Cove trail serves as the only legal public access to the lakeshore of Crater Lake and is one of the most heavily visited destinations in the Park (Figure 1). The trail switchbacks across the steep inner wall of the Crater Lake caldera, and the active erosional forces shaping this area have resulted in a backlog of hazard management and functional repair needs (Figure 2). The Cleetwood Cove trail is approximately 1.1 miles long and 5-6' wide with a grade ranging from 2-20%. The Cleetwood Cove Rock Scaling project is the first effort in a multi-phase endeavor to rehabilitate the Cleetwood Cove trail and marina. Extensive rock scaling has been deemed necessary in three areas with the highest rated unstable slopes where the trail travels below crumbling cliff bands. Additional phases of the project will improve retaining walls, the trail surface, and the marina as the recently constructed dock and bulkhead on the lakeshore have partially failed and need reconstruction (Figure 3). The CRLA Botany program has been tasked with conducting revegetation and restoration of the natural areas disturbed by construction activities.

The Cleetwood Cove Rock Scaling project will focus on designated high-priority slopes (shaded areas in Figure 1). Impacts from rock scaling will include removal of large and small live and dead trees, including downed trees and woody debris. Rock scaling will impact vegetation present in the fall zone below the scaling activity. Slopes are very steep in this area and there is potential for materials to tumble to the lakeshore at high velocity and impact mature vegetation. Retaining walls, rockwork, and the trail surface may be damaged by this process and need repair, which may cause further damage to mature vegetation along the trail.

Vegetation serves an essential role in anchoring unstable soils on steep slopes, especially the spreading root systems of large, mature vegetation such as shrubs and trees. Revegetation efforts will be necessary to protect the trail and slope by reestablishing vegetation cover. Revegetation efforts will also improve the aesthetics of the trail corridor for Park visitors and establish native vegetation cover in barren areas to protect against establishment of non-native, invasive plant species. To date, no invasive plant species have been detected along the Cleetwood Cove trail or marina area although they have been encountered within the parking lot, lakeshore, and along nearby East Rim Drive. The vegetation community within the Crater Lake caldera is diverse, unique, and pristine. The establishment and spread of invasive plant species would have devastating impacts to the caldera's vegetation, especially since invasive vegetation management work in this area is extremely difficult to implement due to limited access and dangerous terrain. Preventing the introduction and spread of non-native, invasive plant species will be critical to the success of the Cleetwood Cove Rock Scaling project.

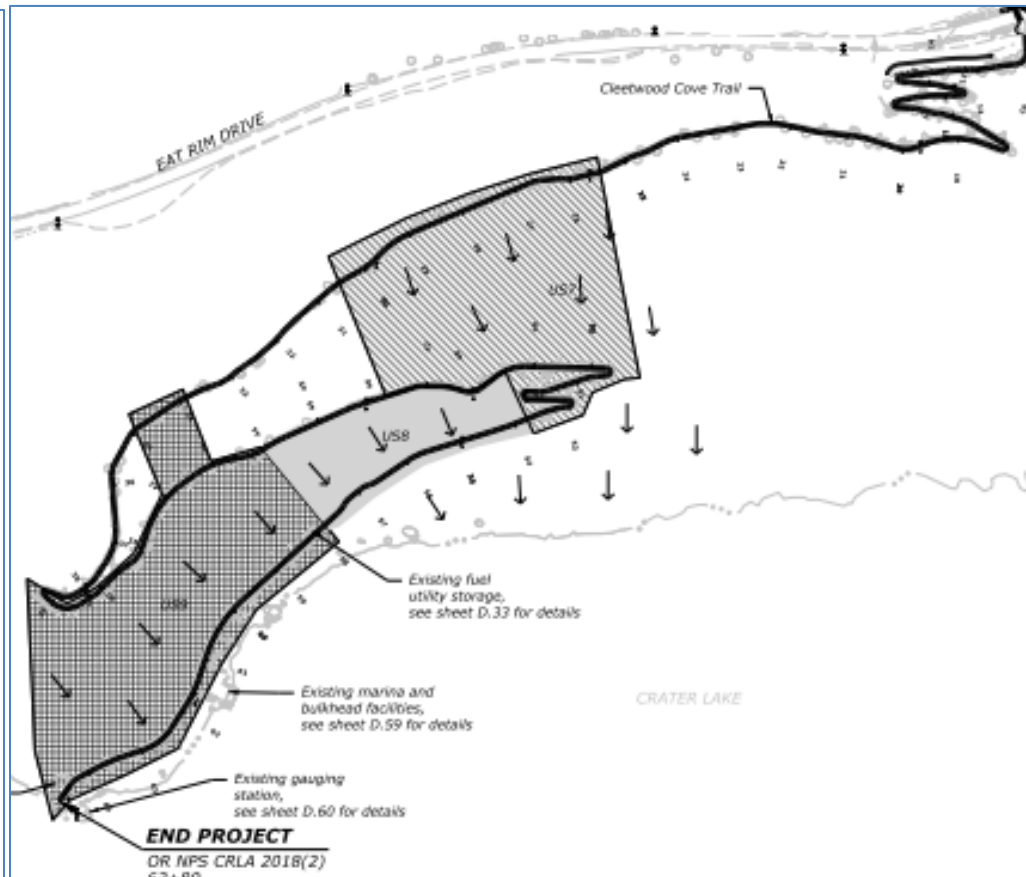


Figure 1. The Cleetwood Cove trail location in Crater Lake National Park (left). Map by Scott Heisler. Distinct rock scaling zones to occur in shaded areas with patterns denoting the three distinct rock scaling zones (right). Map provided by the Federal Highways Administration.



Figure 2. Failing cribbing and rock retaining wall (left); unstable, rocky pumice soils (right) on the Cleetwood Cove trail. Photos by Carrie Wyler.



Figure 3. View of Crater Lake's shoreline and failed dock and bulkhead. Photo by Carrie Wyler.

The rock scaling phase of the project commenced in the fall of 2020 through exploratory geotechnical drilling; widespread rock scaling is planned for fall of 2022. This activity is expected to create large swaths of disturbed ground (Figure 4). In anticipation of this, in 2020 the Botany program developed revegetation prescriptions for the area, collected native plant seed, began propagating plants, and conducted invasive vegetation surveys. Due to the Covid-19 pandemic, work during the 2020 field season was hindered by the inability to hire adequate numbers of staff members, with a resulting larger workload for a smaller staff. This resulted in lower amounts of plant materials and seed gathered and will need to be compensated for in future years.



Figure 4. Planned rockfall mitigation and scaling areas on the Cleetwood Cove trail. Areas outlined in yellow indicate fall zones for scaled rock. Yellow arrows indicate pathways where the scaled rock and debris will fall. Map provided by the Federal Highways Administration.

Methods

Revegetation

Site Prescriptions

The first step in revegetation planning was gathering information about the native plant species present on the Cleetwood Cove trail. The upper area of the trail is characterized by mountain hemlock (*Tsuga mertensiana*), western white pine (*Pinus monticola*), Shasta red fir (*Abies magnifica* x *Abies procera*), and ponderosa pine (*Pinus ponderosa* var. *ponderosa*) mixed conifer forest. The lower area of the trail is dominated by a green-leaved manzanita (*Arctostaphylos patula*), showy rabbitbrush (*Ericameria nauseosa* var. *speciosa*), and bush ocean spray (*Holodiscus microphyllus* var. *glabrescens*) shrubland with clusters of trees on steep pumice slopes (Figure 5).

Revegetation site prescriptions and a plant species list for the project area were developed in July of 2020, prior to the commencement of exploratory geotechnical drilling. These prescriptions document the pre-disturbance site features and plant species composition unique to the area and serve as baselines to guide plant material needs and the evaluation of restoration efficacy.

Revegetation prescriptions were developed by making site visits and recording habitat characteristics, dominant plant species, and an ocular estimate of each species' relative cover. Additional information collected included microsite factors (e.g. downed wood, available organic materials) that could aid establishing plants, wind exposure of the site, and aspect. Photo points were established, and photos were taken of the pre-disturbance site. Further information on the specifics of the process can be found in Gregory et al. (2015).



Figure 5. Forested area at the top of the trail (left); open shrubland with isolated trees present on the bottom half of the Cleetwood Cove trail (right). Photos by Carrie Wyler.

Native Seed Collection and Processing

Using the revegetation prescriptions as a reference, seed was collected from grasses, forbs, and shrubs within a mile of the project area. Seeds were not collected from all plant species listed in the revegetation prescriptions during the 2020 season, and seeds from additional species may be collected in subsequent years. Seed collection in 2020 targeted the most abundant plant species in the project area, and ones that the Botany program has experienced the most success with propagating and planting in prior restoration projects. 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 the population is slated for removal due to construction, in which case as much seed as possible should be collected. The seed collection process commenced in 2020 by observing and documenting the phenology of each targeted species in the project area (Table 1). Seeds were collected according to the Botany program’s established Seed Collection Protocols (Beck et al. 2017). All seed, except sticky currant (*Ribes viscosissimum*) was dried and sent to the USFS Dorena Genetic Resource Center (DGRC) for cleaning and storage.

Table 1. 2020 plant phenology (month/day) for the Cleetwood Cove trail area.

Common Name	Scientific Name	Leaf	Bud	Flower	Fruit	Seed
Sitka alder	<i>Alnus alnobetula</i> ssp. <i>sinuata</i>	**	**	**	8/14	9/24
California brome	<i>Bromus sitchensis</i> var. <i>carinatus</i>	6/24	**	**	7/07	8/02
Common squirreltail	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	**	**	**	7/23	8/02
Showy rabbitbrush	<i>Ericameria nauseosa</i> var. <i>speciosa</i>	6/24	7/23	8/2	8/14	9/28
Western needlegrass	<i>Eriocoma occidentalis</i>	7/07	**	**	7/23	8/14
Bush ocean spray	<i>Holodiscus microphyllus</i> var. <i>glaberscens</i>	**	**	7/23	8/02	9/24
Cliff penstemon	<i>Penstemon rupicola</i>	6/24	**	8/02	8/14	9/01
Sticky currant	<i>Ribes viscosissimum</i>	**	**	**	8/14	9/24

** Information not available

Plant Propagation

Plant propagation for this project is being handled by the DGRC in Cottage Grove, Oregon, with the exception of *Ribes* species. Sticky currant was propagated at the Park from seed; methodology is maintained in the Botany program's nursery and plant propagation files. Propagation of native plants from seed poses difficulties for the Botany program due to the lack of equipment for cold stratification of seeds and the year-round staffing required for early season plant care. To address these difficulties, plant propagation techniques utilize Crater Lake's abundant snowpack to cold stratify seeded pots, allowing the plant propagation schedule to align with the present Botany field season (Figure 6).



Figure 6. Seeding containers with sticky currant seed (left). Propagated pots with rodent-exclusion screens overwintered for cold stratification (right). Photos by Carrie Wyler.

Invasive Vegetation Management

Several factors within the project area contribute to a high risk for the introduction and spread of new invasive plant populations: potentially contaminated equipment being brought into the Park, and its use in off-trail, heavily disturbed locations; the status of the Cleetwood Cove trail as one of the most heavily visited areas in the Park; and the extensive nature of anticipated ground disturbance.

Invasive Vegetation Management (IVM) efforts before, during, and after construction work will be a critical component of ensuring project success. See the 2020 IVM Annual Report (Hasty et al. 2021) for detailed methodology on invasive plant survey and control. During 2020, IVM efforts consisted of surveys for new invasive plant populations (Figure 7), investigation of previously recorded populations (2003-present), and treatment of any populations found per the Park's Invasive Vegetation Management Plan (DOI NPS 2017).



Figure 7. Surveying for invasive plants along the Cleetwood Cove trail. Photo by Carrie Wyler.

Results

Revegetation

Site Prescriptions

The revegetation prescriptions for the Cleetwood Cove trail area were completed in 2020. Table 2 shows the completed site prescription form for the bottom section of the trail; the site prescription form for the upper portion of the trail is listed in Table 3.

Table 2. Revegetation prescription for the lower Cleetwood Cove trail project.

Seed Zone: NE/Skell		Location ID: Cleetwood	Planned site
Location: Bottom half of Cleetwood Cove trail			
Site Description: Rock scaling work to be done on lower half (bottom) of Cleetwood Cove trail (see Figure 4)			
Pre-Disturbance Site Information			
Plant Species	Common Name	Relative % Cover	
<i>Alnus alnobetula</i> ssp. <i>sinuata</i>	Sitka alder	4	
<i>Arctostaphylos nevadensis</i> and <i>Arctostaphylos patula</i>	Pinemat manzanita Green-leaved manzanita	40	
<i>Bromus sitchensis</i> var. <i>carinatus</i>	California brome	1	
<i>Chimaphila umbellata</i>	Pipsissiwa	1	
Conifer species	Small conifers	9	
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	Common squirreltail	1	
<i>Ericameria nauseosa</i> var. <i>speciosa</i>	Showy rabbitbrush	19	
<i>Eriocoma occidentalis</i>	Western needlegrass	1	
<i>Holodiscus microphyllus</i> var. <i>glabescens</i>	Bush ocean spray	15	
<i>Penstemon rupicola</i>	Cliff penstemon	5	
<i>Ribes viscosissimum</i>	Sticky currant	5	
Other		1	
	Total Cover:	100%	
Associated species: <i>Chamaenerion angustifolium</i> var. <i>canescens</i> , <i>Antennaria media</i> , various fern species, <i>Chrysolepis sempervirens</i> , <i>Calyptridium umbellatum</i> , <i>Linanthus pungens</i>			
UTM (Zone 10, NAD 83):	Beginning (top): 0574735	Beginning(top): 4758959	
Total Vegetative Cover: 15%		Elevation: 6200 ft. at bottom	
Slope: Very steep	Aspect: varies	Snowmelt out:	
Soil “hardness,” presence of rocks: Very rocky, but with loose pumice “soil”			
General Soil description: Pumice			
Ameliorating microsite features: Rocks and conifer debris			
Wind exposure: low	Canopy cover (overall): Spotty, relatively low at bottom		
Area:			
Comments: Unsure of disturbance footprint until after the rock scaling is completed in fall 2022.			
Date for Site Restoration to begin: Fall 2022			
Description of Site Disturbance for Restoration need: Unknown at this time			
Recorder: CW, SH		Date: 7/28/20	

Table 3. Revegetation prescription for the upper Cleetwood Cove trail project.

Seed Zone: NE/Skell		Location ID: Cleetwood	Planned site
Location: Top half of the Cleetwood Cove trail			
Site Description: Rock scaling work to be done on upper half (top) of Cleetwood Cove trail (see Figure 4)			
Pre-Disturbance Site Information			
Plant Species	Common Name	Relative % Cover	
Arctostaphylos nevadensis and Arctostaphylos patula	Pinemat manzanita and Green-leaved manzanita	50	
Bromus sitchensis var. carinatus	California brome	1	
Chimaphila umbellata	Pipsissiwa	5	
Conifer species	Small conifers	30	
Elymus elymoides ssp. elymoides	Common squirreltail	10	
Eriocoma occidentalis	Western needlegrass	1	
Holodiscus microphyllus var. glabescens	Bush ocean spray	10	
Penstemon rupicola	Cliff penstemon	1	
Ribes viscosissimum	Sticky currant	2	
Other		1	
	Total Cover:	100%	
Associated species: Chamaenerion angustifolium var. canescens, Antennaria media, various fern species, Chrysolepis sempervirens, Calyptridium umbellatum, Linanthus pungens			
UTM (Zone 10, NAD 83):	Beginning (top): 0574735	Beginning(top): 4758959	
Total Vegetative Cover: 20%		Elevation: 6832 ft.	
Slope: Very steep	Aspect: varies	Snowmelt out:	
Soil “hardness,” presence of rocks: Very rocky, but with loose pumice “soil”			
General Soil description: Pumice			
Ameliorating microsite features: Rocks and conifer debris			
Wind exposure: low	Canopy cover (overall): Spotty, high at top, mid-varies		
Area:			
Comments: Unsure of disturbance footprint until after the rock scaling is completed in fall 2022.			
Date for Site Restoration to begin: Fall 2022			
Description of Site Disturbance for Restoration need: Unknown at this time			
Recorder: CW, SH		Date: 7/28/20	

Native Seed Collection and Processing

Individual accessions of seed were collected from nine plant species during the 2020 field season (Table 4). Collected seed was dried at the seed drying facilities in the Stall Nine garage at Park headquarters (Figure 8) and sent to the DGRC for cleaning and storage.

Table 4. Amount of seed collected by plant species in 2020.

Scientific Name	Common Name	Quantity (grams)
<i>Eriocoma occidentalis</i>	Western needlegrass	38.74
<i>Alnus alnobetula</i> ssp. <i>sinuata</i>	Sitka alder	20.72
<i>Bromus sitchensis</i> var. <i>carinatus</i>	California brome	44.21
<i>Ericameria nauseosa</i> var. <i>speciosa</i>	Showy rabbitbrush	1.09
<i>Holodiscus microphyllus</i> var. <i>glaberscens</i>	Bush ocean spray	0.33
<i>Penstemon rupicola</i>	Cliff penstemon	0.71
<i>Ribes viscosissimum</i>	Sticky currant	2.0
N/A	Species mix	0.5
TOTAL		108.3



Figure 8. Seed drying facility in the Stall 9 garage. Photos by Carrie Wyler.

Plant Propagation

Eight plant species were targeted for plant propagation efforts in 2020 (Table 5). At CRLA, a total of 196 pots were seeded with sticky currant in November of 2020 and are presently in cold stratification under the snowpack at the Park's Ball Diamond. Seven species are being propagated at the DGRC; five from seed, and two from cuttings: pinemat manzanita (*Arctostaphylos nevadensis*) and green-leaved manzanita (*Arctostaphylos patula*). Germination and rooting success will be evaluated during the 2021 field season.

Table 5. Number of seeded pots for plant propagation in 2020.

Scientific Name	Requested number of plants from the DGRC	Number of Pots Seeded at CRLA
<i>Alnus alnobetula</i> ssp. <i>sinuata</i>	60	0
<i>Arctostaphylos nevadensis</i> **	100	0
<i>Arctostaphylos patula</i> **	200	0
<i>Chrysolepis sempervirens</i>	10	0
<i>Ericameria nauseosa</i> var. <i>speciosa</i>	196	0
<i>Holodiscus microphyllus</i> var. <i>glabrescens</i>	200	0
<i>Penstemon rupicola</i>	196	0
<i>Ribes viscosissimum</i>		196
Total	962	196

**Plants propagated from cuttings

Invasive Vegetation Management

The project area includes the Cleetwood Cove parking lot, the length of the Cleetwood Cove trail and adjacent slopes, the bulkhead and dock, and the swimming beach along the lakeshore. These areas were surveyed repeatedly during the 2020 field season, and no invasive plants were detected. The last time invasive plants were encountered within the project area was 2014-2017. Small populations of annual bluegrass (*Poa annua*), red sand-spurrey (*Spergularia rubra*), and Dutch clover (*Trifolium repens*) were encountered in the Cleetwood Cove parking lot. All of these populations were treated with manual control methods and have not reappeared.

Discussion

The 2021 field season will require continued seed collection and plant propagation efforts. Plant propagation success needs to be evaluated in the summer of 2021 and adjustments made to ensure adequate plant establishment and growth.

In October of 2020, exploratory geotechnical bore holes were drilled to determine the underlying rock strata. The drilling sites will need to be surveyed for non-native, invasive plant species in future years. Frequent invasive plant surveys throughout the entire project area need to continue throughout the 2021 and subsequent field seasons. The Cleetwood Cove trail traverses the very steep Crater Lake caldera walls and venturing off-trail is dangerous. The establishment of invasive plant species within the caldera would be catastrophic for native plant communities, as the terrain makes invasive plant treatment and control very difficult to impossible. As construction planning proceeds, it is imperative that measures to prevent the introduction of invasive plant species get incorporated into project design and material sourcing and transport.

Social trail creation along the Cleetwood Cove trail is something that needs to be watched for and remedied immediately. Continued collaboration with the Trails program will be necessary to ensure that social trail obliteration and soil decompaction occurs concurrently with trail restoration.

The sandy/ashy pumice soils that are abundant on the Cleetwood Cove trail area may pose additional challenges to revegetation efforts due to their softness/erodibility and well-drained natures. Soils may need more amendments (e.g., compost, organic material) than have been used on other revegetation projects in the Park. In heavily eroded areas, slope stabilization efforts may be required prior to revegetation. Larger plants, including trees and shrubs such as pinemat manzanita, sticky currant, Sitka alder, and showy rabbitbrush may be especially effective at anchoring soils in erosive areas around and on slopes.

The timeline for project implementation is still uncertain; presently it is believed that this project will occur in the fall of 2022. If the project schedule is delayed, many plants grown for restoration outplanting will need to be held over at the Ball Diamond nursery. This requires transplanting into larger containers and subjecting the plants to regular care and watering during the summer months as planting is most successful at CRLA during the fall season. The longer the project is delayed, the more mortality will be experienced by container plants, requiring additional plant materials to be gathered and propagated. Project delays also place a drain on limited seasonal staffing as nursery work is significant and requires overtime on the weekends to ensure regular watering. It is hoped that this project does not experience significant delays, and revegetation efforts can continue as planned.

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