



Cleetwood Cove Trail and Marina Rehabilitation Revegetation Project

2021 Annual Report



**ON THIS PAGE**

Park visitors hiking the steep Cleetwood Cove trail that traverses the Crater Lake caldera.
Photo by Carrie Wyler.

ON THE COVER

Cribbing retaining wall in need of repair along the Cleetwood Cove trail.
Photo by Carrie Wyler.

Cleetwood Cove Trail and Marina Rehabilitation Revegetation Project

2021 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
Whitebark Pine Survey.....	4
Native Seed Collection and Processing.....	6
Plant Propagation and Plant Care.....	6
Invasive Vegetation Management.....	7
Results	8
Revegetation	8
Whitebark Pine Survey.....	8
Native Seed Collection and Processing.....	9
Plant Propagation and Plant Care.....	10
Invasive Vegetation Management.....	11
Discussion.....	11
Literature Cited	12

Figures

	Page
Figure 1. The Cleetwood Cove trail location in Crater Lake National Park (left). Rock scaling to occur in shaded areas with patterns denoting distinct rock scaling zones (right).....	2
Figure 2. Deteriorated cribbing and rock retaining wall (left); unstable, rocky pumice soils (right) on the Cleetwood Cove trail.....	3
Figure 3. Example of some of the slope stabilization and rockfall mitigation work that will be done on the Cleetwood Cove Trail.	3
Figure 4. View of Crater Lake’s shoreline with failed dock and bulkhead..	4
Figure 5. Surveying for whitebark pine on steep caldera slopes (left). Determining the age class of a whitebark pine (right)..	5
Figure 6. Shadehouse structure used to house plants for Cleetwood and other Park projects..	7
Figure 7. Plants being prepared for overwintering (left). Overwintered plants covered in snow (right).....	7
Figure 8. Results of the preliminary whitebark pine survey along the Cleetwood Cove Trail in the anticipated project area.....	8
Figure 9. Comparison of projected rock scaling areas (gray shading) on the Cleetwood Cove Trail as planning efforts progressed for this project. Left: Initial rockfall mitigation (November 2020) plans on the left that guided whitebark pine surveys in 2021. Right: updated rockfall mitigation plans (late September 2021) that were released after the preliminary whitebark pine survey was completed.....	9
Figure 10. Seed drying facility in the Stall 2 garage..	10

Tables

	Page
Table 1. Whitebark pine age class criteria parameters.	5
Table 2. 2021 plant phenology (month/day) for the Cleetwood Cove trail area.....	6
Table 3. Quantity of seed collected by plant species in 2021.	9
Table 4. Number of seeded pots for plant propagation in 2020 and the number of plants in inventory fall 2021.	10

Abstract

Crater Lake National Park's (CRLA) popular Cleetwood Cove trail provides the only legal public access to the shoreline of Crater Lake. Extensive rehabilitation efforts are being planned to rebuild the trail and marina and improve trail safety via rockfall mitigation. The Botany program at CRLA has been tasked with revegetation and restoration work in areas disturbed by rock scaling and rockfall mitigation; trail stabilization and retaining wall reconstruction; and reconstruction of marina facilities. Revegetation work for this project commenced in 2020 as the project was slated to begin in 2022. The project timeline has since been delayed and now construction is planned to begin in the summer of 2024. Revegetation work completed on this project in 2021 included collecting plant materials, surveying the area for whitebark pine (*Pinus albicaulis*), caring for nursery plant stock propagated in 2020, and invasive vegetation management. These efforts resulted in collection of seed from six plant species and surveying the project area for invasive plants. Revegetation work planned for the 2022 season includes expanded seed collection efforts, additional propagation of nursery stock, care of propagated plants, expanded whitebark pine surveys, and continued surveys for invasive plant species.

Acknowledgments

This project benefited from collaboration with the Crater Lake National Park Facility Management division; the assistance of Kirsten Hardin and Andrew Hoeg is greatly appreciated. Funding for this project was provided by the National Park Service Recreation Fee program. David Larkin, River Allen, and members of the Northwest Youth Corps assisted with seed collection. The U.S. Forest Service Dorena Genetic Resource Center provided seed cleaning and plant material production services.

Introduction

Crater Lake National Park's (CRLA) Cleetwood Cove trail serves as the only legal public access to the shore 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 to the lakeshore, 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 feet wide with a grade ranging from 2-20%. At the bottom of the trail, marina and restroom facilities support boat operations and recreational use by Park visitors. The marina and bulkhead failed shortly after reconstruction over the 2015-2016 winter and are presently safety hazards and aesthetic nuisances. The current restroom facilities along the lakeshore are inadequate to support levels of use.

The Cleetwood Cove Trail and Marina Rehabilitation project is a multi-phase endeavor to redesign and rebuild these facilities to support visitor use, research and monitoring, and boat operations. Extensive rock scaling above and below the trail has been deemed necessary in areas with unstable slopes where the trail travels below crumbling cliff bands and rock outcrops (Figure 3). Additional slope reinforcing efforts such as installing anchored mesh, shotcrete, and rock bolts may be utilized as needed to secure the slope for trail users. This project will also fortify the trail tread by replacing and/or strengthening retaining walls, failing cribbing, and the trail surface. Lastly, the marina and restroom facilities will be reconstructed as the existing failed bulkhead needs to be removed and rebuilt, and the existing composting toilet is no longer meeting present use needs (Figure 4). The CRLA Botany program has been tasked with ensuring revegetation and restoration of natural areas disturbed by construction activities are completed.

The first phase of the Cleetwood Cove Trail and Marina Rehabilitation project will focus on mitigating rockfall hazard (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 and marina area 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 nearby areas. 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

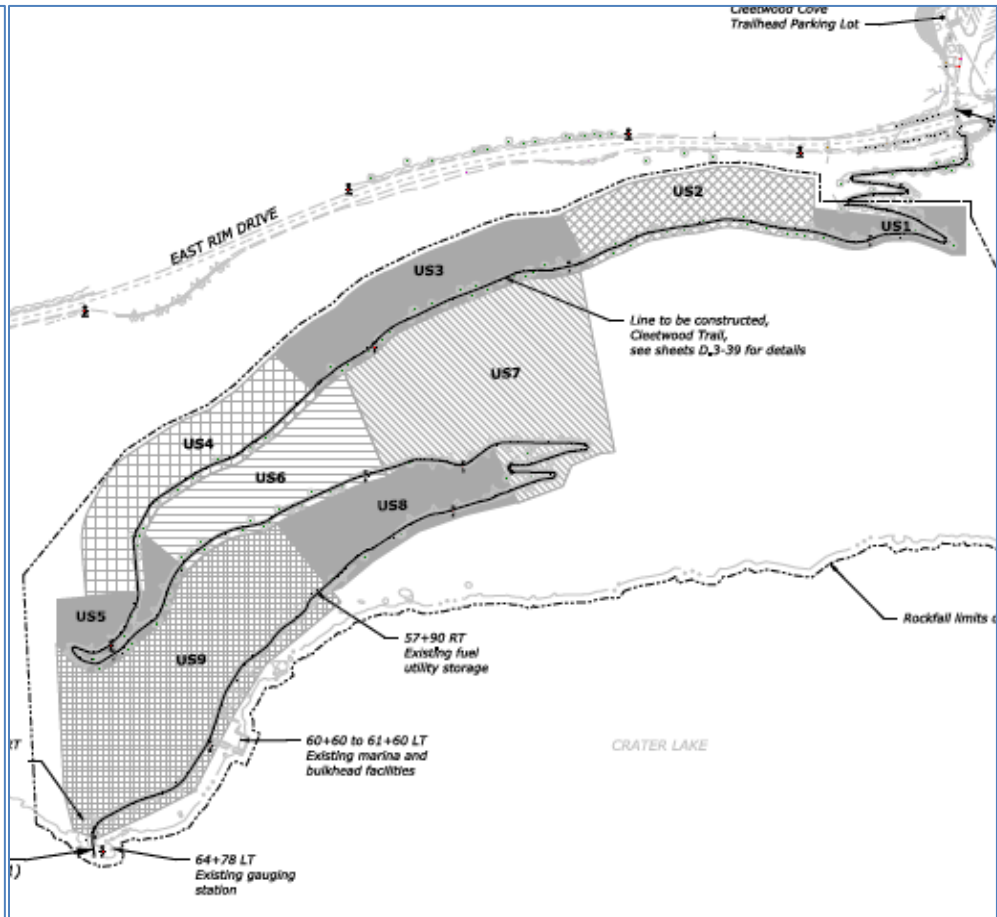
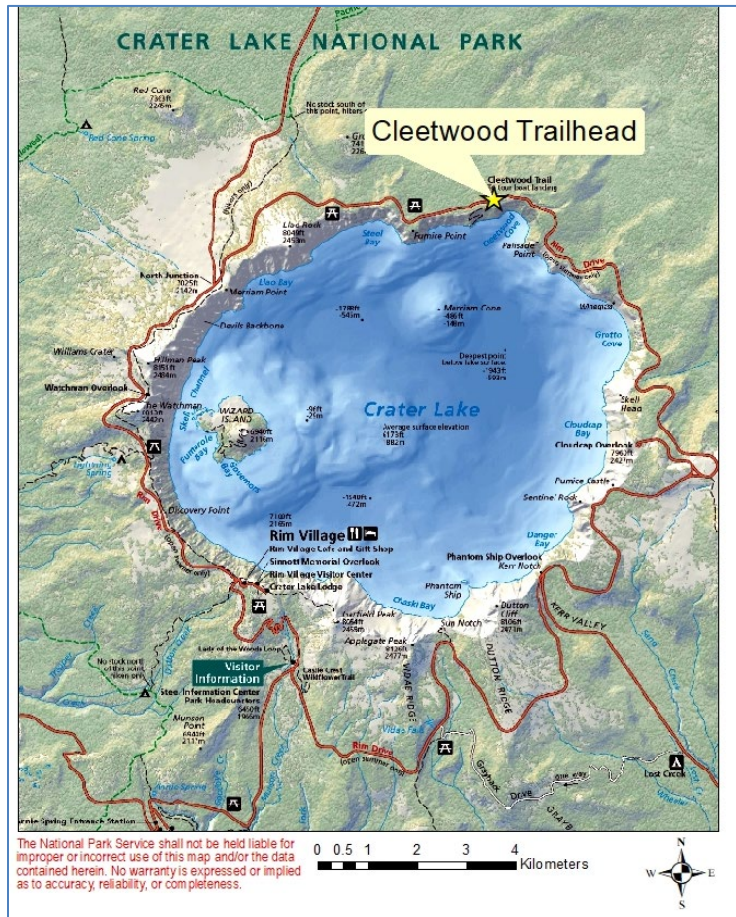


Figure 1. The Cleetwood Cove trail location in Crater Lake National Park (left). Map by Scott Heisler. Rock scaling to occur in shaded areas with patterns denoting distinct rock scaling zones (right). Map provided by the Federal Highways Administration.



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

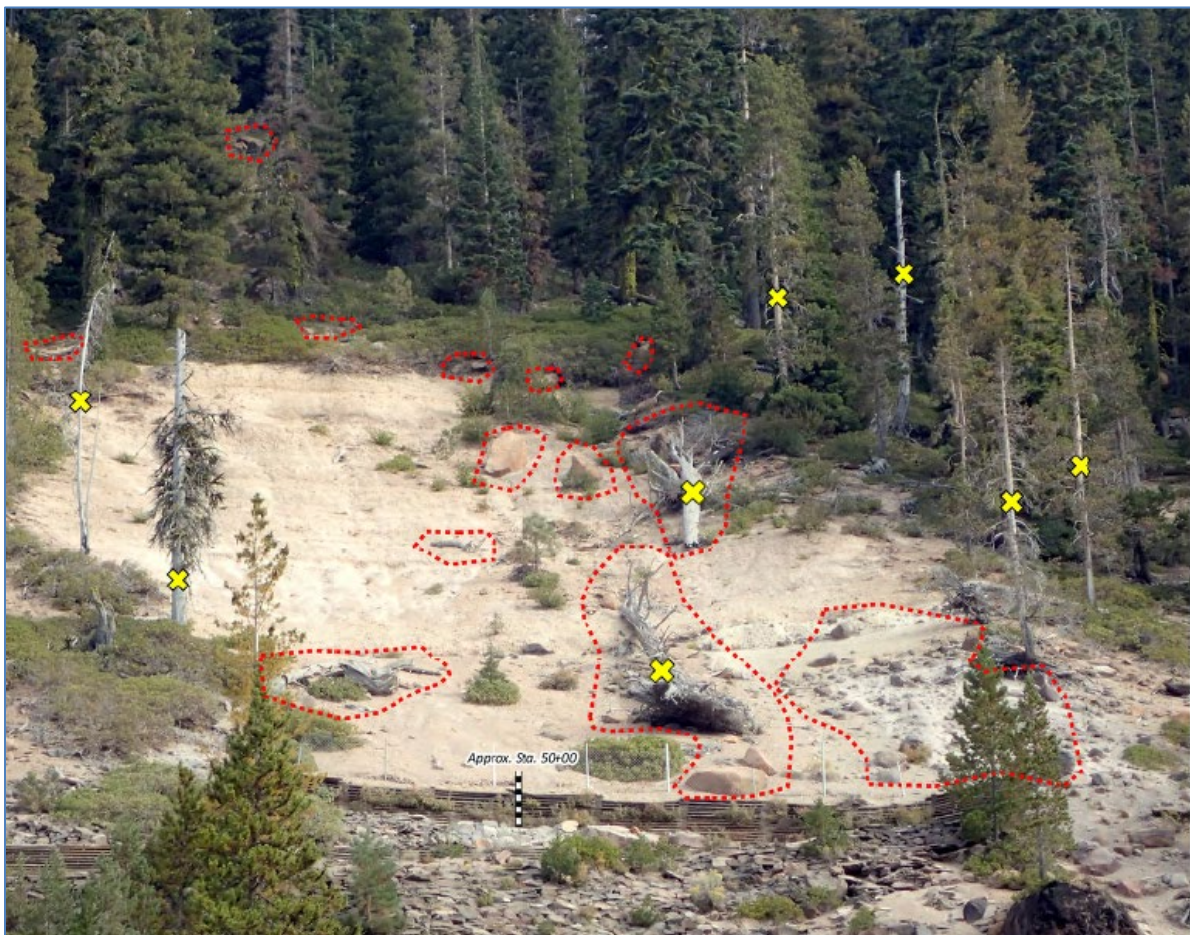


Figure 3. Example of some of the slope stabilization and rockfall mitigation work that will be done on the Cleetwood Cove Trail. Image courtesy of the Federal Highways Administration.



Figure 4. View of Crater Lake's shoreline with failed dock and bulkhead. Photo by Carrie Wyler.

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 this project.

Initially planned for fall of 2020, active rock scaling work for the project has been delayed until spring/summer of 2024, with trail and marina rehabilitation planned for the summer/fall of 2024-2025. The process of rock scaling is expected to create large swaths of disturbed ground within the project area. In anticipation of this, the Botany program developed revegetation plans for the area (Wyler et al. 2021), collected native plant seed, propagated plants, and conducted invasive vegetation surveys. In 2021, additional seed was collected, the area was surveyed for invasive vegetation, and the upper trail sections were surveyed for whitebark pine (*Pinus albicaulis*) – a species that has been proposed to be listed as threatened under the federal Endangered Species Act.

Methods

Revegetation

Whitebark Pine Survey

It was initially assumed that few whitebark pines occurred within the project area, but a closer inspection revealed whitebark pine concentrated in an area between the upper Cleetwood Cove trail and cliff bands above the trail in areas slated for intensive rock scaling work. Whitebark pine is an imperiled natural resource within the Park and throughout its range. To protect this species, an initial survey of whitebark pine within the project area was conducted in September of 2021.

The survey was conducted by traversing along slopes adjacent to the trail and marking the location of all encountered whitebark pine using a high-accuracy GNSS receiver (Leica GG04 Plus; Figure 5). The Federal Highway Administration's Cleetwood Cove Rock Scaling construction plans (70%

design phase) were used as a reference to determine the impact area. Whitebark pines within the impact area were assigned an age category based on size (Table 1). Some trees were not accessible due to unstable slopes and occurrences on cliff faces; these trees were mapped as close to their physical location as possible, with a note added to the attributes detailing the situation. Given the potential for the whitebark pine survey to create rockfall above a heavily used trail, a temporary trail closure was implemented for the duration of the survey.

Table 1. Whitebark pine age class criteria parameters.

Age Class	Criteria
Seedling	< 30 cm height
Sapling	30-130 cm height
Mature Understory	< 15 cm DBH
Mature Overstory	> 15 cm DBH

*DBH = diameter at breast height



Figure 5. Surveying for whitebark pine on steep caldera slopes (left). Determining the age class of a whitebark pine (right). NPS photos.

Native Seed Collection and Processing

Using the 2020 revegetation prescriptions as a reference, seed was collected from grasses, forbs, and shrubs within a mile of the project area. Seed collection in 2020 and 2021 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 2021 by observing and documenting the phenology of each targeted species in the project area (Table 2). Seeds were collected according to the Botany program’s established Seed Collection Protocols (Beck et al. 2017). All seed, except sticky currant (*Ribes viscosissimum*) and bush chinquapin (*Chrysolepis sempervirens*) were dried and sent to the USFS Dorena Genetic Resource Center (DGRC) for cleaning and storage.

Table 2. 2021 plant phenology (month/day) for the Cleetwood Cove trail area.

Common Name	Scientific Name	Leaf	Bud	Flower	Fruit	Seed
Bush chinquapin	<i>Chrysolepis sempervirens</i>	**	**	**	8/18	9/22
Showy rabbitbrush	<i>Ericameria nauseosa</i> var. <i>speciosa</i>	6/29	7/26	8/17	8/31	9/20
Western needlegrass	<i>Eriocoma occidentalis</i>	**	**	6/29	7/12	7/26
Bush ocean spray	<i>Holodiscus microphyllus</i> var. <i>glabescens</i>	**	6/29	7/12	8/18	9/20
Cliff penstemon	<i>Penstemon rupicola</i>	**	6/29	7/12	7/26	8/18
Sticky currant	<i>Ribes viscosissimum</i>	**	**	**	8/18	9/1

** Information not available

Plant Propagation and Plant Care

An initial round of plant propagation for this project was conducted at CRLA in the fall of 2020. These plants were cared for at CRLA’s native plant nursery at the Park’s Ball Diamond (Figure 6) during the 2021 growing season. In addition to the plants grown at CRLA, a shipment of plants grown for the project at the DGRC was retrieved from Cottage Grove, OR in September 2021. These plants were examined for quality and cared for by the Botany staff during the 2021 growing season. Excess growth was manually trimmed with scissors or hedge clippers as needed. Any reproductive structures were removed to promote root development and prevent excess evapotranspiration, and dead growth was removed to discourage fungal growth. Undesired plant volunteers originating from the DGRC in the planting tubes (e.g., mosses, liverworts, and weeds) were removed to minimize the risk of introducing non-native plant species to the Park.



Figure 6. Shadehouse structure used to house plants for this and other Park projects. Photos by Carrie Wyler.

Due to the delay in project implementation, all plants are being held over the winter at the Ball Diamond native plant nursery. When ambient temperature dropped below freezing the containers were consolidated and mulch was stacked around the bases of herbaceous plants to prevent root freezing (Figure 7). These plants will need further care in the summer of 2022 including watering, fertilization, transplanting into larger containers, and inspection for invasive plant species.



Figure 7. Plants being prepared for overwintering (left). Overwintered plants covered in snow (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 2021 IVM Annual Report (von Bergman et al. 2022) for detailed methodology on invasive plant survey and control. During 2021, IVM efforts consisted of surveys for new invasive plant populations, investigation of previously recorded populations (2003-present), and treatment of any populations found per the Park's Invasive Vegetation Management Plan (DOI NPS 2017).

Results

Revegetation

Whitebark Pine Survey

In total, 77 whitebark pine trees were encountered in the survey, which were mapped at 60 distinct points (Figure 8). Due to time constraints arising from the trail closure, surveying efforts in some locations were focused on areas marked for rock scaling in the available plan set. This resulted in limiting coverage distance uphill from the trail along the upper, long East-West traverse. The greatest density of whitebark pine in the project area occurs along the caldera rim cliff band above this trail segment. Shortly after conducting the survey, an updated plan set was released which detailed significantly expanded rock scaling areas (Figure 9). In light of this development, further survey work is needed to fully account for whitebark pine within the project area.

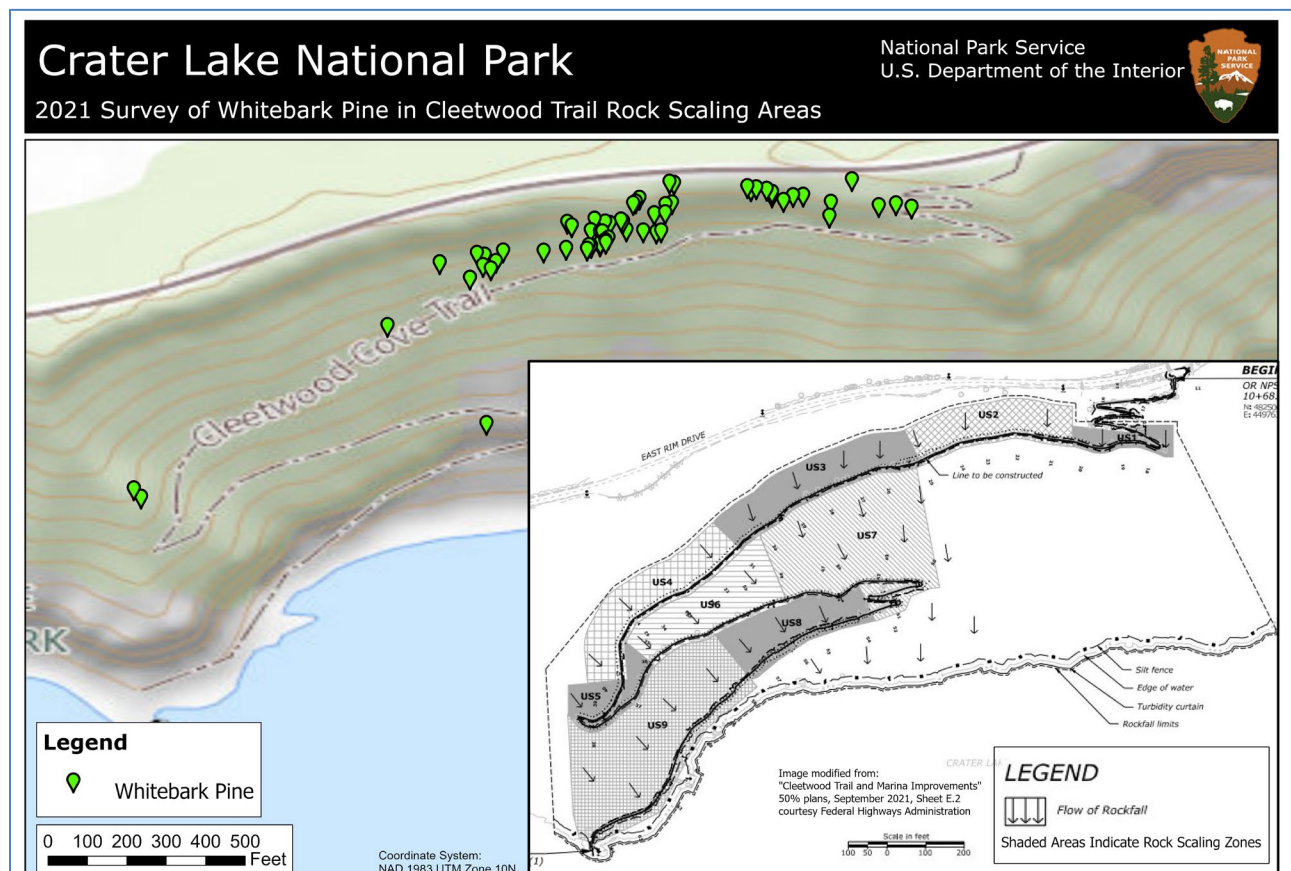


Figure 8. Results of the preliminary whitebark pine survey along the Cleetwood Cove Trail in the anticipated project area. Map by Scott Heisler. Inset map courtesy of Federal Highways Administration.

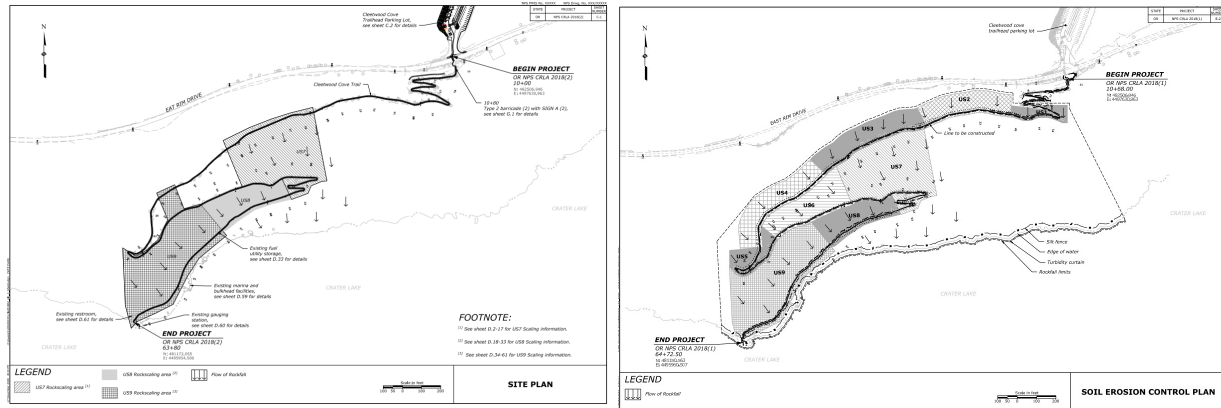


Figure 9. Comparison of projected rock scaling areas (gray shading) on the Cleetwood Cove Trail as planning efforts progressed for this project. Left: Initial rockfall mitigation (November 2020) plans on the left that guided whitebark pine surveys in 2021. Right: updated rockfall mitigation plans (late September 2021) that were released after the preliminary whitebark pine survey was completed. Images courtesy of the Federal Highways Administration.

Native Seed Collection and Processing

The peak seed collection period for most plant species occurred from early August to mid-September. The 2021 growing season was notable for extreme drought conditions and the hottest summer on record as reported by the servicing National Weather Service office (Sandler 2021), including a severe heat wave in mid-June. The effect of these biotic stresses in the project area was readily visible in plant growth rates and seed production quantities.

Individual accessions of seed were collected from five plant species during the 2021 field season (Table 3). Collected seed was dried at the seed drying facilities in the Stall Two garage at Park headquarters (Figure 10). Some seed collected during 2021 was sent to the DGRC to be cleaned and stored until needed. Seed collected as mixes and seed from certain easy-to-clean species was cleaned in-house by Botany program staff.

Table 3. Quantity of seed collected by plant species in 2021.

Scientific Name	Common Name	Quantity (grams)
<i>Chrysolepis sempervirens</i>	Bush chinquapin	37
<i>Ericameria nauseosa</i> var. <i>speciosa</i>	Showy rabbitbrush	34
<i>Holodiscus microphyllus</i> var. <i>glaberscens</i>	Bush ocean spray	0.71
<i>Penstemon rupicola</i>	Cliff penstemon	25
<i>Ribes viscosissimum</i>	Sticky currant	1
N/A	Species mix	85
TOTAL		182.71



Figure 10. Seed drying facility in the Stall 2 garage. Photos by Carrie Wyler.

Plant Propagation and Plant Care

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 seven species were propagated at the DGRC; five from seed, and two from cuttings: pinemat manzanita (*Arctostaphylos nevadensis*) and green-leaved manzanita (*Arctostaphylos patula*). An inventory of surviving germinated plants as of 2021 can be found in Table 4. Due to delays in project implementation, no plant propagation for this project was initiated in 2021.

Table 4. Number of seeded pots for plant propagation in 2020 and the number of plants in inventory fall 2021.

Scientific Name	Requested number of plants from the DGRC in 2020	Number of Pots Seeded at CRLA in 2020	Plants in inventory as of fall 2021
<i>Alnus alnobetula</i> ssp. <i>sinuata</i>	60	0	67
<i>Arctostaphylos nevadensis</i> **	100	0	141
<i>Arctostaphylos patula</i> **	200	0	0
<i>Ericameria nauseosa</i> var. <i>speciosa</i>	196	0	20
<i>Holodiscus microphyllus</i> var. <i>glabrescens</i>	200	0	91
<i>Penstemon rupicola</i>	196	0	167
<i>Ribes viscosissimum</i>	0	196	85
Total	962	196	571

**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 restrooms and swimming beach along the lakeshore. These areas were surveyed repeatedly during the 2021 field season, and no invasive plants were detected. The last time invasive plants were encountered within the project area was 2017; however invasive plant survey efforts were limited in 2018-2019. 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 in 2020. All of these populations were treated with manual control methods and have not reappeared.

Discussion

The 2022 field season will require continued seed collection and plant propagation efforts. Plant survival success needs to be evaluated in the summer of 2022 and adjustments made to ensure adequate plant establishment and growth. Root-bound plants will need to be transplanted into larger containers as soon as practical after the snow melts. If plants aren't transplanted, many will die due to being extremely root-bound. Plants will need fertilization to assist with survival and growth. All containerized plants should be checked for moss, liverwort growth, and weeds and they should be removed if present.

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 has been delayed until spring of 2024. Plants that have already been produced 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. If necessary, these plants can be used in revegetation efforts at the Cleetwood Cove trailhead and in the parking lot landscaping islands. and a new batch of plant materials produced to better match the updated construction schedule and implementation timeline.

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