



Pacific Crest Well Pipeline Revegetation Project

2018 Annual Report



**ON THIS PAGE**

Drilling planting holes in compacted soil with an augur ahead of outplanting salvaged plants.
Photo by Carrie Wyler.

ON THE COVER

Outplanting salvaged plants in the area disturbed by installing new water and power lines.
Photo by Carrie Wyler.

Pacific Crest Well Pipeline Revegetation Project

2018 Annual Report

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Abstract

In 2017 Crater Lake National Park converted an existing exploratory groundwater well into a supplemental potable water source, the Pacific Crest Well. Development of pumping infrastructure and a transport pipeline created approximately 2.3 acres of bare-ground disturbance alongside a popular Park entrance road and regional transportation corridor. The Crater Lake National Park Botany program received funding to carry out vegetative restoration of this impacted area, with a project length of three years. In the second year (2018) of the project, restoration efforts consisted of continued site monitoring; propagation of native plant materials from seed collected during the 2017 field season; soil rehabilitation; outplanting of plants salvaged from the area before it was disturbed; native seed collection, cleaning, and storage; and invasive vegetation management. Results of these efforts consisted of propagating 3,136 plants; outplanting 189 salvaged plants; collecting 2,587 grams of native seed; rehabilitating disturbed soils; and invasive vegetation management surveys which investigated 57 historic noxious weed population sites and documented and treated 13 current populations. Due to continued delays in the construction schedule, large sections of the project area were excluded from these restoration efforts and will be addressed during the 2019 field season.

Acknowledgments

The Crater Lake National Park Maintenance division provided funding to support this work. The Crater Lake National Park Invasive Vegetation Management crew (J.C. McNelly, Delacey Randall, Thomas Hender, Hamilton Hasty, and Alissa Iverson) assisted with invasive plant survey and control, and outplanting of salvaged plants. The Crater Lake National Park Roads crew facilitated restoration efforts by recontouring slopes, smoothing disturbed soils, and placing boulders to deter further impacts from off-pavement parking. The assistance of Kirsten Hardin was appreciated in enforcing construction turnback standards.

Introduction

Crater Lake National Park's (CRLA) Annie Spring Supplemental Potable Water Plan (ASSPWP) was originally drafted in 2015 in response to the need for a reliable, adequate, long-term source of potable water to support the Park's developed areas (NPS 2016). In May of 2017, a water call was placed on the park's primary potable water source, Annie Spring, expediting the ASSPWP-proposed conversion of an existing exploratory well into a new potable water source, the Pacific Crest Well (PCW). In the summer of 2017, construction commenced for the creation of well pumping infrastructure, an underground pipeline connecting the PCW to existing water supply lines, and an underground utility (electrical power, pump control communication) conduit for the newly created well.

In total, the project created approximately 2.3 acres of bare, heavily disturbed ground alongside portions of Oregon State Highway 62 and Munson Valley Road in the vicinity surrounding CRLA's Annie Spring entrance station. In anticipation of this disturbance, CRLA's Botany program petitioned for and received funding to mitigate the impact on native vegetation communities, and to restore the scenic beauty of this high profile roadside viewshed (Figure 1). The funds support salary and supply costs for a seasonal Biological Science Technician (Plants) to achieve the following tasks:

- Survey for and control non-native, invasive plant species within project area to prevent introduction and spread
- Develop a revegetation plan for seed collection, site repair, broadcast seeding, and planting
- Collect native seeds and plant materials from adjacent wildlands
- Dry, clean, process, and store collected plant materials
- Prepare seed mixes for broadcast seeding
- Rehabilitate disturbed soils through adding native organic materials such as Park-sourced compost and woody debris
- Propagate native herbaceous and shrubby plants for restoration plantings
- Broadcast seed of native grasses, forbs, sedges, and shrubs



Figure 1. Heavy roadside disturbance along Highway 62. Photo by Jen Hooke.

- Monitor efficacy of restoration efforts and augment seeding/planting as needed to restore barren areas
- Produce annual reports of efforts and findings

In order to ensure the success of revegetation and invasive plant survey & control efforts, the project was budgeted to span three years: 2017-2019. In the first year of the project, all construction activities were scheduled to be completed, but primary construction work was not concluded until September 2018. Installation of an underground electrical line is planned, and continuing disturbance to limited sections of the project area is anticipated from this activity. Restoration efforts in 2018 focused on two distinct components: revegetation (plant propagation, soil rehabilitation, outplanting of salvaged plants, native seed collection/processing, and seeding), and invasive vegetation management (IVM). These components will be discussed separately in the methods and results sections.

Methods

Revegetation

Revegetation efforts targeted disturbed areas surrounding the wellhead and expanded Pacific Crest Trail parking lot, the length of pipeline/conduit trenching alongside Highway 62, the area alongside the existing Mazama storage tanks access road, and the run of pipeline/conduit trenching from the Mazama storage tank access road to the Mazama booster pump under the Annie Creek bridge on Munson Valley Road. These areas notably exclude the run of pipeline/conduit trenching connecting the Mazama storage tank access road area to the Highway 62 roadside area, as this stretch follows an

old highway grade that will be utilized as a service road. The project area is highlighted in Figure 3.



Figure 2. Planning for revegetation efforts prior to construction. Photo by Jen Hooke.

A revegetation plan was developed in 2017 containing revegetation prescriptions and site documentation for the two main habitats and plant communities observed within the project area (Figure 2). The area was divided into two zones: an upper zone dominated primarily by grasses, sedges, and forbs; and a lower zone that was more densely forested. This documentation was created to provide guidelines for restoration efforts and to serve as a baseline from which to monitor the progress of these efforts. The documentation will need extensive updates in 2019 to assess 2018 restoration efforts.



Figure 3. Areas disturbed by the PCT Well Pipeline are highlighted in yellow and total 2.3 acres. Map by Scott Heisler.

Plant Propagation

Propagation of native plants from seed poses difficulties for the Botany program due to the lack of equipment for cold stratification of seeds and the year-round staffing required for early season plant care. To address these difficulties, an experimental round of propagation was conducted in May 2018 that utilized the remaining snowpack to cold stratify seeded pots and aligned the plant propagation schedule with the present Botany field season. Given the success of this experiment, a more extensive round of seeded pots was prepared in October 2018 for overwintering under the snowpack to replicate natural germination conditions.

For the May 2018 experimental propagation, Ray Leach “SC7 Cone-tainer” pots were placed in racks and then filled and settled to 0.5” below the top rim with Premier “PRO-MIX HP Mycorrhizae” soil. These pots were then seeded with a small pinch of one of two roughly cleaned native seed mixes collected from the restoration area during the 2017 field season. A thin (~1/8”) layer of soil was then placed over the seeds, and the pots were watered. The seeded pots were placed into an 8’ deep hole, dug to the ground level in the snowpack at the Botany program’s space at the Ball Diamond at Park

headquarters. To prevent rodent predation on the seeds, wood frames covered with 1/8" hardware cloth were placed over the racks (Figure 4). The hole was then backfilled with snow. To extend the duration of the cold stratification period, additional snow was piled on the top of the racks to maintain cover as the snowpack melted. Snow cover was maintained on top of the racks for three weeks (Figure 4). These racks remained covered by the rodent-excluding screens for another three weeks, and then placed, uncovered, inside the Botany program's shadehouse and watered according to established Botany program protocol. To address initial over-seeding, in August 2018 the plant growth was thinned down to three—four plants per pot by careful plucking with tweezers.

The pots, soil, and preparation used for the October 2018 propagation were the same as used in the May 2018 propagation. The seed used for the October 2018 propagation was collected from the restoration area during the 2018 field season, and seeds from individual plant species were utilized rather than species mixes. The selection of perennial species used for propagation was based on the Botany program's past experience with successful containerized propagation for other restoration projects. The seeded pots were placed under rodent-excluding screens, and left to cold stratify over the winter. For overwintering, all of the pots were placed in a tight group, and mulch was packed around the perimeter to protect roots from exposure to severe cold and desiccation (Figure 5).



Figure 4. Left: Racks of pots were protected from rodent predation and buried in snow to expose seeds to freezing temperatures to stimulate germination. Photo by Carrie Wyler. Right: Snow cover was maintained on the racks for three weeks. Photo by Carrie Wyler.

Soil Rehabilitation

Construction activities in the restoration area resulted in soils stripped of surface features and organic materials. Soils denuded in this fashion have a diminished ability to catch wind-blown seed, absorb rainfall, retain moisture, and provide microsite shelter to aid seedling establishment and growth. Additionally, the presence of bare disturbed areas alongside roadways and trails invite further disturbance from vehicle and foot traffic. To address this, small- to medium-sized woody debris and forest litter were dispersed across the project area (Figure 6). The organic materials used were sourced from sites adjacent to the project area.

Prior to adding organic debris, soils were raked and smoothed as needed by the Revegetation crew to destroy berms and obliterate vehicle tracks left behind by construction contractors. Additionally, some areas required heavy equipment to re-contour slopes, smooth and feather out fill piles and edges, and remove excessive amounts of rocks and boulders that would be impediments to revegetation. The CRLA Roads crew rehabilitated these heavily disturbed areas and prepared them for restoration efforts.



Figure 5. Racks of pots bunched together for overwintering at the Ball Diamond. Photo by Carrie Wyler.



Figure 6. Addition of woody debris and forest litter incorporated organic matter into disturbed soils. Photo by Carrie Wyler.

Outplanting of Salvaged Plants

In anticipation of construction activities, 189 containers of mature perennial plants (assorted grasses, sedges, forbs, shrubs, and mosses) growing in areas of planned heavy disturbance were salvaged from the project area in 2017. The areas these plants were salvaged from were completely stripped of vegetation by construction activities, and placing mature plants back into these areas provides early *in situ* seed sources and “nurse plant” ecological facilitation.

Outplanting of these salvaged plants was conducted in October 2018. Outplanting was conducted following standard practices used by the Botany program. Due to extremely compacted soils in the restoration area resulting from construction activity, an auger bit attached to a gas engine drill was used to create holes for planting. The 3.5” auger bit was driven repeatedly into the selected planting sites, forming areas of loosened soil modestly larger and deeper than the one-gallon pots the salvaged plants were contained in. Each loosened planting hole was then cleared of enough soil to place a plant’s root ball into it (level with the surrounding ground). The root ball and loose soil surrounding it were then tamped down, and a small water catching well was formed with soil adjacent to the planting site. A handful of Park-sourced compost was added to each planting site, and the planting was generously watered to settle the roots (Figure 7).

Native Seed Collection and Processing

Seed collection targets were initially set at 15 lbs. /acre (6.8 kg/acre), with a disturbed area size of around 1.1 acres based on the project’s 2015 environmental assessment (NPS 2016). As previously stated, the actual disturbed area has reached 2.3 acres.

Native seed was collected from all grasses, sedges, rushes, forbs, and shrubs that were encountered within one mile of the project area (Table 1). The dense forest canopy cover and depauperate understory found in the lower project area restricted fruitful collection to roadsides and forest openings. Additional seed collection areas in forest openings along the Pacific Crest Trail were explored this year. Seeds were collected according to the Botany program’s established Seed Collection Protocols (Beck et al. 2017). This seed was then dried and cleaned according to the Botany program’s Seed Cleaning and Short Term Storage Protocol (on file on the Botany server). Limited collections of individual species were maintained during collection and processing for use in plant propagation. The remaining seed was combined for use in broadcast seeding conducted in October 2018.



Figure 7. Outplanting of salvaged native plants to help jumpstart vegetative recovery in disturbed areas.
Photo by Carrie Wyler.

Table 1. List of plant species from which seed was collected with observed 2018 phenologies. Asterisks indicate unavailable data for that phenological phase.

Scientific Name	Leaf	Bud	Flower	Fruit	Seed
<i>Achnatherum occidentale</i>	6/27	*	7/02	*	7/15-8/28
<i>Anaphalis margaritacea</i>	*	*	6/26	*	7/12-8/28
<i>Boechera howellii</i>	*	*	6/26	6/26	7/12-8/20
<i>Bromus carinatus</i> var. <i>carinatus</i>	*	*	6/26	7/2	7/12-8/20
<i>Carex breweri</i>	*	*	6/26	*	7/15
<i>Carex halliana</i>	*	*	6/26	6/26	7/30-8/6
<i>Carex inops</i> ssp. <i>inops</i>	*	*	6/26	7/2	7/15-8/6
<i>Carex pachycarpa</i>	*	*	6/26	6/26	7/12-8/7
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	*	6/26	6/26	*	7/16-8/15
<i>Elymus glaucus</i> ssp. <i>glaucus</i>	*	*	*	*	8/6-8/28
<i>Ericameria greenei</i>	*	*	*	*	9/27
<i>Eriogonum pyrolifolium</i> var. <i>coryphaeum</i>	*	*	6/26	*	7/30
<i>Eriogonum marifolium</i> var. <i>marifolium</i>	*	*	6/26	*	7/12-7/30
<i>Juncus parryi</i>	*	6/26	6/26	*	7/09-7/23
<i>Lupinus andersonii</i>	*	*	6/26	7/07	7/12-8/20
<i>Lupinus lepidus</i> var. <i>lobbii</i>	*	*	6/26	*	7/12-8/27
<i>Luzula hitchcockii</i>	*	*	*	6/26	7/12-7/26
<i>Nothocalais alpestris</i>	*	*	*	6/26	6/26
<i>Penstemon rydbergii</i>	*	*	6/26	*	7/15
<i>Phacelia mutabilis</i>	*	*	6/26	*	7/30
<i>Phlox diffusa</i>	*	*	6/26	*	7/15
<i>Viola species</i>	*	*	*	7/2	6/27-8/20

Seeding

Broadcast seeding of the project area was carried out in October 2018, utilizing a seed mix composed of all species of native seed collected from the project area during the 2018 field season. This seed mix was combined with a carrier of Park-sourced compost, and broadcasted by hand. The seeded area was then lightly raked to increase seed retention and seed-to-soil contact (Figure 8). The areas targeted for seeding were those deemed unlikely to be impacted by further construction disturbances, and excluded the areas surrounding the utility vaults along Highway 62 and the access path for the utility vaults near the Annie Creek bridge on Munson Valley Road. The remainder of the seed

collected during the 2017 and 2018 seasons was set aside for seeding in the areas excluded during this round of broadcast seeding, and for reseeding areas as needed.



Figure 8. Raking in hand-broadcast seed mixes along Highway 62. Photo by Carrie Wyler.

Invasive Vegetation Management

Given the project area location, IVM stands as a critical component of a successful revegetation effort. Highway 62 serves as both a portal into the Park, as well as a thoroughfare for vehicles crossing between the Rogue and Klamath basins. The PCT trailhead is a staging area for horses and pack-stock and the PCT is a popular trail through the Park. Mazama Village and Campground are located near the PCW pipeline corridor, and both areas have well-established populations of invasive plants. The heavy usage received by this area increases the risk for introduction of invasive plant seeds coming from outside the Park; combined with the high levels of disturbance found in the PCW pipeline corridor, establishment of new invasive plant populations is likely.

IVM measures taken include conducting area surveys and controlling invasive plant species, both before and during construction. See the 2018 IVM Annual Report (Hooke et al. 2019) for detailed methodology on invasive plant survey and control. Historic invasive plant populations were investigated using the IVM program's geodatabase, which maintains invasive plant records from

2003—present, and newly discovered populations were added to the geodatabase. A new Invasive Vegetation Management Plan was finalized in July of 2017. This enabled the Botany program to utilize herbicide application as a control method Park-wide; prior to this herbicide application had been limited to a once-yearly treatment of roadside St. John’s wort (*Hypericum perforatum*). Chemical treatment methods will likely be vital assets in managing future invasive plant populations in the project area.

Results

Revegetation

Revegetation efforts in 2018 were focused on collecting plant materials, and planting and seeding in areas unlikely to experience continued construction disturbance.

Plant Propagation

In total, 3,136 pots were seeded for propagation (Figure 9), as outlined in Table 2. All of the 1,274 pots seeded in the May 2018 experimental round of propagation produced germinated plants. This bodes well for continued in-Park plant propagation efforts at CRLA, despite the staffing limitations of the current Botany program. These plants experienced modest growth during the 2018 growing season at the Ball Diamond. These plants were not planted in the fall of 2018 in order to allow the root systems more time to become established, with the hopes that this would help their establishment success when planted in the field.



Figure 9. Seeding containers with a forb mix for plant propagation. Photo by Carrie Wyler.

Table 2. Plant propagation efforts for 2018.

Date	Plant Species	# of Containers Propagated
5/09/18	Forb seed mix	294
5/08/18	Grass seed mix	980
10/04/18	<i>Achnatherum occidentale</i>	490
10/04/18	<i>Boechera howellii</i>	98
10/04/18	<i>Bromus carinatus</i> var. <i>carinatus</i>	490
10/04/18	<i>Carex pachycarpa</i>	294
10/04/18	<i>Elymus elymoides</i> ssp. <i>elymoides</i>	490
Total		3,136

Soil Rehabilitation

Woody debris and forest litter were spread over bare surfaces encountered across the entire project area. This included excessively wide spots alongside the service access roads. Heavy rehabilitation work by the Roads crew greatly facilitated revegetation efforts by pushing disturbed areas closer to natural conditions and placing boulders along roadsides to protect restoration efforts from vehicle damage (Figure 10). The Revegetation crew applied finishing touches by hand to reduce the impacts of construction and help soil recovery by incorporating local, site-specific organic materials (Figure 10).



Figure 10. Top: Before (left) and after (right) slope recontouring work by the CRLA Roads crew. Photos by Jen Hooke. Bottom: (left) Adding organic debris to and smoothing out disturbed soils; (right) boulder placement to prevent damage of restored areas by vehicles. Photos by Carrie Wyler.

Outplanting of Salvaged Plants

All 189 containers of plants salvaged in 2017 contained living plants at the time of outplanting (Figure 11), and were replanted in the areas where they were salvaged. They will be monitored in 2019 for survival and establishment success. Revegetation areas experiencing poor survivorship will be augmented with additional planting and seeding efforts in 2019. Outplanting propagated plants in the project area will commence in 2019.



Figure 11. Left: Salvaged plant materials prior to being outplanted in disturbed areas. Right: planting salvaged plants near the Annie Spring trail. Photos by Carrie Wyler.

Native Seed Collection and Processing

A total of 2,587 g of rough-cleaned native seed was collected during the 2018 field season, as outlined in Table 3. The seed remaining in storage after 2018 broadcast seeding and propagation efforts is detailed in Table 4. This seed was dried and cleaned at the Park (Figure 12), and is stored in the Botany program's seed storage freezer. This will be available for subsequent seeding and plant propagation efforts. Additional seed collection efforts will be made during the 2019 field season, especially from plant species that have exhibited high levels of field survivorship.



Figure 12. Rough-cleaning seed at Park headquarters. Photo by Carrie Wyler.

Table 3. Native seed collected during the 2018 field season.

Plant Species	Amount in Grams
<i>Achnatherum occidentale</i>	238
<i>Boechera howellii</i>	8
<i>Bromus carinatus</i> var. <i>carinatus</i>	249
<i>Carex pachycarpa</i>	524
<i>Carex</i> species	262
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	330
<i>Elymus glaucus</i> ssp. <i>glaucus</i>	260
<i>Lupinus andersonii</i> and <i>Lupinus lepidus</i>	238
Custom Seed Mix	478
Total	2,587

Table 4. Collected native seed remaining in storage

Plant Species	2018 Collected Seed in Storage (g)	2017 Collected Seed in Storage (g)
<i>Achnatherum occidentale</i>	236	0
<i>Boechera howellii</i>	7	0
<i>Bromus carinatus</i> var. <i>carinatus</i>	246	0
<i>Carex pachycarpa</i>	519	0
<i>Carex</i> species	262	0
<i>Elymus elymoides</i> ssp. <i>elymoides</i>	330	0
<i>Elymus glaucus</i> ssp. <i>glaucus</i>	260	0
<i>Lupinus andersonii</i> and <i>Lupinus lepidus</i>	238	605
Forb/Shrub Seed Mix	0	342
Grass/Sedge/Rush Seed Mix	0	1,358
Total	2,098	2,305

Seeding

In October 2018, 478 g of rough cleaned native seed collected during the 2018 field season was used for broadcast seeding in the project area. The seed mix utilized for this consisted of all species encountered during seed collection.

Invasive Vegetation Management

The entire project area was surveyed for invasive plant species, including fifty-seven historic populations. Thirteen populations of invasive plant species were encountered, mapped, and treated in 2018 (Figure 13). The most commonly encountered invasive plant species in the project area were smooth brome (*Bromus inermis* – 185 plants); sheep sorrel (*Rumex acetosella* – 955 plants); and dandelion (*Taraxacum officinale* – 106 plants), with a total of 1,252 plants treated. Other invasive plant species encountered included white clover (*Trifolium repens*), oxeye daisy (*Leucanthemum*

vulgare), flannel mullein (*Verbascum thapsus*), pineapple weed (*Matricaria discoidea*), and red sandspurry (*Spergularia rubra*).

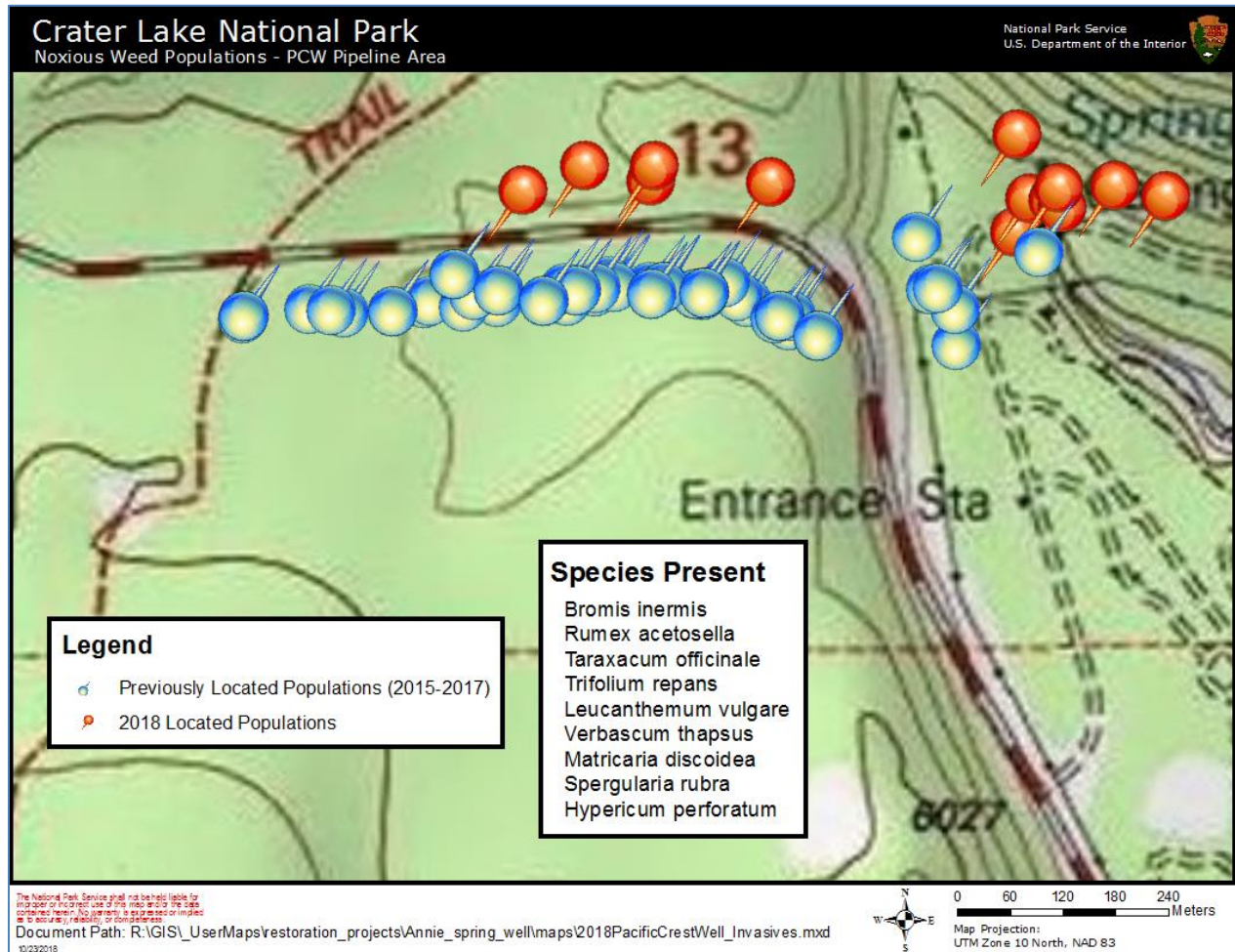


Figure 13. Invasive plant populations treated in 2018. Map by Scott Heisler.

Discussion

Continuing delays in project completion have resulted in extensive areas persisting for another year without any rehabilitative action. This threatens the vegetative recovery of these areas, as restoration funding runs dry at the end of 2019. If construction on the project remains incomplete as of the fall of 2019, additional funding for restoration activities may be required. It is recommended that communication be maintained with Park Maintenance staff regarding the timing of future construction activities. It will be necessary for construction staff to avoid driving through restored areas along Highway 62, since these areas are in a fragile state of recovery. Placement of “Restoration Area” signage may assist in deterring contractors from driving along the road prism in this area.

Outplanting activities in the project area this year revealed the extreme level of soil compaction resulting from construction. Soil compaction diminishes soil structure, resulting in decreased seedling recruitment, stunted plant growth, and decreased absorption of precipitation. It is recommended that measurable soil de-compaction requirements be included in future construction contracts where heavy equipment will be used on non-roadway surfaces.

IVM in the project area, especially areas of continued construction disturbance, will require regular surveying to identify new invasive plant populations and treat them before they become established or set seed. The Park's expanded range of invasive species control options will likely help reduce the persistence and spread of invasive plant populations. The areas being used as service roads should receive attention in IVM efforts, and notice should be given that utility vehicles must be cleaned and inspected before using these roads as per standard Park policy.

Despite continued collection efforts in expanded seed collection areas, the amount of collected native seed still falls short of ideal levels for the size of the project area. Factors contributing to this shortfall are the unplanned drastic increase in actual disturbed area size, limited native seed collection areas, and limited funding available for this project. To address the shortfall, it is recommended that seed collection efforts be continued in 2019.

Early assessment of the plant propagation work completed this year is promising, but plant growth is limited by the short growing season at the Ball Diamond. Production of mature plants ready for outplanting will likely require at least two growing seasons. Shifting plant propagation facilities from the high elevation Ball Diamond to the lower-elevation South Yard may result in increased plant growth and shorten the time required to produce viable plant materials. The warmer conditions present at the South Yard would require careful attention to care and watering of the developing plants.

Continued monitoring of disturbance areas and revegetation methods utilized will be essential over the next several years to ensure that recovery and vegetative succession are jumpstarted and proceeding as desired. Detailed documentation of experimental plant propagation methods will greatly aid future Botany staff as plant propagation becomes a more established function of the Botany program.

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