



Invasive Vegetation Management

2022 Annual Report



**ON THIS PAGE**

A rainbow arcing over Wizard Island as seen from Wizard Island Overlook in Crater Lake National Park. Photo by Brian Pitt.

ON THE COVER

Invasive Vegetation Management crew member searches for historic locations of invasive plant populations above Sun Creek. Photo by Javonn Sims.

Invasive Vegetation Management

2022 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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Acknowledgments

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Introduction

The 2022 field season marked the twentieth year of recurring management of nonnative, invasive plant species within Crater Lake National Park (CRLA). Invasive species are widely recognized as being one of the largest threats to natural areas; as such, the National Park Service (NPS) has been charged with preventing the introduction of nonnative, invasive plant species and controlling infestations of invasive plants where they have become established (USDI NPS 2006). Responding quickly to new invasions and controlling existing infestations of invasive plants are important functions of CRLA's Invasive Vegetation Management (IVM) program.

Due to its high elevation position spanning the Cascade crest, the early designation of CRLA as a protected area (1902), its abundant snowfall, and its relatively short growing season, CRLA has been better protected against invasion by nonnative plant species than some of the other NPS units. The IVM program at CRLA is tasked with protecting, maintaining, and improving the integrity of its native plant communities.

The goals of the IVM program are as follows:

1. *Prevention*: prevent the introduction and spread of invasive plant species within CRLA.
2. *Early Detection and Rapid Response*: survey for new invasive plant infestations to allow for swift treatment and control.
3. *Effective Control*: control invasive plant species within CRLA through eradication, containment, and reduction of invasive plant population densities and abundance. Utilize an adaptive management framework based on the best available science and current knowledge to determine the most effective and appropriate treatment options for proactively controlling invasive plant species.
4. *Monitoring and Data Management*: monitor treatment efficacy and use results of monitoring to inform management. Manage invasive vegetation data to enable regular reporting of results and progress.
5. *Outreach and Education*: educate and inform CRLA's visitors, employees, and partners on the IVM program and involve them in prevention, control, and monitoring efforts.
6. *Collaboration*: communicate regularly with NPS partners, including other federal, state, and county entities, and collaborate on invasive vegetation management and control.

The 2022 field season was productive and informative for the Invasive Vegetation Management program. The IVM crew consisted of four dedicated members. This was the sixth consecutive year implementing the recently developed Invasive Vegetation Management Plan (USDI NPS 2017), allowing for the usage of herbicide to treat especially time-consuming and difficult-to-control invasive plant species.

Funding was received to survey for and treat invasive plants around CRLA's facilities (e.g., buildings, roads, trails) from the NPS Natural Resource Cyclic Maintenance program. Support was

received from the NPS Adaptive Forest Management project to fund interns to assist with invasive plant survey and control work in association with fuels reduction work. Two twenty-week interns were hired through the American Conservation Experience program for the 2022 season. Additional funding was received from Phase II of the Rim Drive Rehabilitation project, the Steel Visitor Center Rehabilitation project, and the Sun Notch, Plaikni Falls, and Rim Trail rehabilitation projects to survey for and treat invasive plant species within project areas.

Crater Lake National Park received 440 inches of snow over the 2021—2022 winter, which is approximately 91% of the average annual snowfall of 481 inches. Despite this, CRLA was in severe drought conditions for the duration of the 2022 field season. Park headquarters (~6,400' elevation) experienced snow-free conditions on July 1st. Field work commenced on May 16th and ended on October 6th. There were no large fires near CRLA in 2022 and the crew's ability to complete field work was not limited due to area closures or poor air quality, which have occurred in previous seasons. Inclement weather such as lightning and extreme temperatures did halt field work on some occasions. Large projects causing ground disturbance were limited to continuing fuel break and defensible space creation by the CRLA Fire Management program along North Entrance Road; vegetation clearing along south Highway 62 by the CRLA Roads program; and the Steel Visitor Center Rehabilitation project. Large projects slated for implementation in 2023 include completion of the Steel Visitor Center Rehabilitation project and commencement of Phase II of the Rim Drive Rehabilitation project.

Methods

Crater Lake National Park has been divided into five IVM Zones: Backcountry, Developed Areas, Lakeshore, Roadside, and Staging Areas. These zones are subdivided into IVM regions where survey and control efforts are targeted. Each region is a “problem area” where invasive plants are known to be concentrated, have recently been detected, or have a high probability of becoming established. The control strategy for each region varies depending upon which invasive plant species it contains as well as terrain and other ecological considerations. General control strategies for invasive plant species are containment – preventing new infestations and spread; reduction – reducing the size and extent of existing infestations; and eradication – extirpating the plant species from CRLA.

Nonnative plant species at CRLA are given a management priority of high, medium, low, or watch (Appendix A). 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 those species are not aggressively spreading, or populations are beyond control. Watch species are those that have been documented within CRLA, but have not been observed in >10 years, or species that are found outside of and proximal to CRLA. If any watch species are found within CRLA, they receive a management priority of high. These management priorities may change depending upon situation and location. For example, a low priority species may be controlled if found in a wilderness environment that is mostly free of

nonnative plant species and its control is feasible. A high priority species may not be treated in a specific region where its population is beyond control. Low priority species may be controlled concurrently at sites where high priority species are being treated.

Vegetation surveys consist of visually searching a region for invasive plants (Figure 1), typically on foot but occasionally via boat or automobile. The IVM crew navigates to known invasive plant locations with the aid of GPS units, and in most instances uses a grid formation to survey for invasive plants. This entails the crew lining up and spacing out so there are no gaps in the field of vision between crew members; the width between crew members can vary based on terrain and vegetation structure. The line is led by a crew member on the end who navigates with a GPS unit, and as crew members visually search the area for nonnative plants, they follow the direction of the end person, keeping equal spacing between one another. The crew conducts multiple transects in this manner depending on the extent of historic and contemporary weed populations. In previously unsurveyed areas with no record of invasive plant species, surveys are concentrated on the most likely establishment points, such as open habitats, areas with moist soils or close to water, and recently disturbed habitats. Based on prior experience, it is unlikely to find invasive plant species in dense, closed canopy forests at CRLA.



Figure 1. An IVM crew member hiking over obstacles in search of historic invasive plant populations. Photo by Javonn Sims.

Once an invasive plant population is discovered, data are recorded including scientific name, IVM region where it was found, total number of plants present, area that plants occupy (m²), and treatment applied to the population. Data are input into a tablet computer (Figure 2) equipped with ArcGIS Field Maps linked to the CRLA Botany's ArcGIS Online account. Plants are either pulled from the soil intact using digging knives or sprayed with herbicide via a backpack or hand sprayer. When manual treatments are used, all plant parts capable of reproduction (e.g., inflorescences in the case of plants that reproduce via seed, and rhizomes/corms/tubers for pulled plants capable of vegetative reproduction) are bagged, removed from the site, and disposed of in the trash compactor at park headquarters where they are hauled in a closed truck to the Dry Creek Landfill in White City, Oregon, for burial. Vegetative parts incapable of reproduction are left to desiccate on site unless they present logistical or aesthetic problems for CRLA visitors, employees, and partners.



Figure 2. The IVM crew entering treatment data into tablet computers using Field Maps. Photo by Jen Hooke.

When possible, any new-to-CRLA nonnative plant species encountered are collected as voucher specimens for the CRLA herbarium. Often only one or two individuals are discovered and are destroyed during the plant identification process, so vouchering may not be possible. Nonnative plants encountered in previously undocumented locations within CRLA are also collected for the herbarium.

Crew members carry a booklet containing images and descriptions of the known nonnative plant species in CRLA. This booklet is often sufficient for identifying unknown plants in the field and is updated regularly for accuracy and the inclusion of new nonnative plant species. The tablet computers carried by crew members in the field are also equipped with various region-specific plant

identification applications which aid crew members in identification in conjunction with the CRLA invasive species booklet. If plant specimens found during surveys are not identified in the field, they are bagged and taken back to the office for keying and possible voucher creation. The population location is mapped with a GPS unit and the plant species is entered as ‘Unknown’ in the database and assigned a unique code. The plant is identified immediately before desiccation or decomposition occurs, and if necessary, a voucher specimen is created. Plants that cannot be identified the day of collection are placed in a specimen refrigerator for preservation. Once the plant is identified, the plant species name is changed from ‘Unknown’ to the correct species code in the IVM database.

After the Invasive Vegetation Management Plan was approved in July 2017, the IVM crew started using herbicide as a treatment option. Although many invasive plant species can be successfully treated by hand pulling alone, large populations or species with persistent roots (e.g., deep tap-roots of common dandelion –*Taraxacum officinale*; rhizomes of Canada thistle –*Cirsium arvense*, sheep sorrel –*Rumex acetosella*, and smooth brome –*Bromus inermis*; and extensive fibrous roots of St. John’s wort –*Hypericum perforatum*) are most effectively treated with herbicide. Ten herbicides are approved for use in CRLA with six herbicides submitted and approved for use through the NPS Pesticide Use Permitting System (PUPS) in 2022 (Table 1): Milestone, Roundup Custom, Roundup ProMax, Transline, Plateau, and Polaris AC Complete.

Table 1. Herbicides approved for use under the CRLA Invasive Vegetation Management Plan. Bold type indicates herbicides approved for use in 2022 through the NPS PUPS.

Herbicide	Trade Name	Treatment Type	Use Areas
Aminopyralid	Milestone	Pre- and post-emergence	Terrestrial to water’s edge
Chlorsulfuron	Telar	Pre- and post-emergence	Terrestrial
Clopyralid	Transline	Pre- and post-emergence	Terrestrial, right of way only
Glyphosate	Roundup ProMax, Roundup Custom	Post-emergence	Terrestrial and Aquatic formulations
Imazapic	Plateau	Pre- and post-emergence	Terrestrial
Imazapyr	Polaris AC Complete	Pre- and post-emergence	Terrestrial and Aquatic formulations
Metsulfuron	Escort	Pre- and post-emergence	Terrestrial
Rimsulfuron	Matrix	Pre-emergence	Terrestrial
Sulfometuron	Oust	Pre-emergence	Terrestrial
Triclopyr	Garlon	Post-emergence	Terrestrial and Aquatic formulations

Botany staff obtained Oregon state public pesticide applicator’s licenses with regulatory weed categories or apprentice licenses. Secure storage facilities were maintained for herbicide and spray equipment, with spill kits staged at each storage site including vehicles. Each day herbicide use was expected, site-specific historic invasive plant data were reviewed. That information along with site-specific factors determined the amount and type of herbicide that was brought into the field. Herbicide concentrate was mixed and loaded into spray equipment at appropriate concentrations,

then loaded into a truck bed for transport to the field site. Occasionally, a small bottle of herbicide concentrate would be transported to the field in a truck lockbox if the need to mix more herbicide formulation was anticipated. The crew utilized both backpack and hand sprayers for chemical control. Backpack sprayers are more traditionally used for herbicide application; however, CRLA contains very few invasive plant monocultures, thus hand sprayers generally have sufficient capacity (Figure 3). Hand sprayers have the advantage of being far more portable than backpack sprayers and allow the applicator to carry a normal backpack while working.

When leaving the vehicle and gearing up for the field, hand sprayers are typically placed in dry bags and attached to backpacks for transport to the field site. If backpack sprayers are used, one or two people may be designated to carry water, food, and a first aid kit to support the herbicide applicators. These individuals are also responsible for inputting data into Field Maps on the tablets, as well as navigation. Any herbicide left behind is locked in a box in the truck bed.

When invasive plants are found, the vegetative parts are sprayed with care to avoid spraying non-target species, as well as to minimize herbicide drift. Inflorescences are removed and collected as they can attract pollinators and disseminate seeds before the herbicide causes mortality to the plant, but rhizomes are left intact for herbicide translocation throughout the plant. In the event of late season spraying, leaves may be losing chlorophyll and turning red. In this case, plants are not sprayed. Care is also taken to avoid spraying in wind, on snow, early in the morning when leaves are covered in dew, and before forecasted precipitation. Weather forecasts are checked for rain, strong winds, and lightning before each field day.



Figure 3. An IVM crew member uses a hand sprayer to spray a sheep sorrel patch with herbicide. Photo by Hamilton Hasty.

Data collection for herbicide treatment is almost identical to data entry when treating with manual methods. However, additional data are required to be maintained as per Oregon Department of Agriculture (ODA) regulations including treatment beginning and ending time, amount of herbicide used (ounces per acre), and full names and license numbers of all applicators. The ODA data are recorded and later scanned into electronic records. Herbicide treatment records are then kept for a minimum of three years as per state regulations.

Results

Invasive vegetation survey and control work occurred from May 16 – October 6, 2022.

Approximately 87,182 invasive plants were controlled during the 2022 field season, including four nonnative plant species that had not been previously recorded within CRLA: bullhead (*Tribulus terrestris*), Jim Hill mustard (*Sisymbrium altissimum*), alfalfa (*Medicago sativa*), and creeping yellow wood sorrel (*Oxalis corniculata*). Bullhead is a “B” listed weed on both the Oregon Department of Agriculture and Klamath County weed lists, indicating high priority for control. Creeping yellow wood sorrel was found in containerized plants brought in by a partner nursery; these had escaped pots and were found growing in the Ball Diamond. This brings the number of nonnative plant species documented within CRLA to 96; however, 35 of those species have not been encountered within CRLA in recent years. Control efforts put forth by the 2022 IVM program are presented by general IVM zones.

Backcountry Zone

Crater Lake National Park’s backcountry zone includes areas away from roads, developed areas, staging areas, and the Crater Lake shoreline. A total of 61,206 invasive plants were treated in CRLA’s backcountry areas during the 2022 field season (Figure 8; Tables 2 and 3). The western half of CRLA receives more precipitation from incoming Pacific storms than does the east side due to orographic effects; additionally, there is a history of grazing in some of the recent (1980s) additions to CRLA’s westernmost border. The west side of CRLA has experienced multiple large fires since 2015. Due to these factors, the west side of CRLA generally harbors more invasive plant infestations than the east side.

The IVM crew surveyed all planned sites during the 2022 field season. The crew mainly focused on treating invasive plant populations at existing sites, and were able to expand survey areas and perform follow-up treatments at several sites. When time allowed, new sites were also surveyed. Previously undocumented infestations were encountered within the 2015 National Creek Complex and the 2018 Timber Crater 10 fire perimeters. Backcountry camping was utilized this season to focus on the 2017 Blanket Creek fire’s extensive invasive plant infestations.

In 2022, the 2017 Blanket Creek fire continued to harbor some of the largest invasive plant populations (Figure 4) in CRLA. For reporting purposes, the Red Blanket Canyon and the 2017 Blanket Creek fire have been separated into two regions, although most of the 2017 Blanket Creek fire is embedded within the Red Blanket Canyon area. The Red Blanket Canyon encompasses CRLA’s lowest elevation (3,900’) and contains one of its most diverse floras (Figure 5). Due to its

low elevation, the Red Blanket Canyon site is one of the earliest accessible backcountry sites in CRLA and was the first site the crew visited after everyone had completed training. Later that month, the first three-day backcountry camping trip occurred in the Red Blanket Canyon allowing for a thorough survey of the area, which had not been done since 2019. Approximately 3,370 invasive plants were treated in the Red Blanket Canyon area alone; this is a 426% increase from 2021. In addition, 12,152 invasive plants were treated in the 2017 Blanket Creek fire perimeter over the course of several days. A second three-day backcountry camping trip was planned for this area but cancelled due to illness; however, extra time was spent in the 2017 Blanket Creek fire area to make up for lost time.



Figure 4. Invasive Vegetation Management crew members manually treating a large common mullein infestation. Photo by Jen Hooke.

The most prevalent invasive plant species within the Backcountry region were common mullein (*Verbascum thapsus*), Canada thistle, and bull thistle (*Cirsium vulgare*). There have been cheatgrass (*Bromus tectorum*) infestations previously found in the Red Blanket Canyon, but none were found during the 2022 season. The common mullein and bull thistle populations located farthest to the east appeared to have increased in severity due to a lack of treatment in 2021 because of poor air quality from wildfires. Long days of hiking are required to reach these populations, but in 2022 it was possible to make a tangible and hopefully significant impact on these infestations. Future backcountry camping trips or successive day trips will be imperative to effectively control these infestations.



Figure 5. The IVM crew members climb steep slopes (left); wildflowers cover a rocky outcrop (right) in the floristically diverse Red Blanket Canyon. Photos by Hamilton Hasty.

Surveys in three burned areas within the Backcountry zone detected far fewer invasive plant numbers than previous years. Invasive plant population numbers within the 2016 Bybee Creek fire, 2008 Castle fire, and 2014 Scoria fire areas decreased by 36%, 73%, and 52%, respectively, compared to 2021 findings in the same locations.

In contrast, three burned areas produced significantly increased invasive plant population counts: the 2017 Blanket Creek fire, the Crescent fire of the 2015 National Creek Complex (NCC), and the 2017 Spruce Lake fire. Combining totals from the two IVM regions located within the 2017 Blanket Creek fire perimeter yields 15,882 treated invasive plants in 2022, which is a 170% increase from 2021. In the 2015 Crescent fire (NCC) perimeter, two new infestations of invasive plant species were discovered in 2022: a small population of bulbous bluegrass (*Poa bulbosa*) and several large populations of sheep sorrel (*Rumex acetosella* - Figure 6). This marked the first time bulbous bluegrass was encountered in CRLA's backcountry. Due to these new sheep sorrel populations, the NCC IVM region harbored the largest treated infestations of invasive plant species within CRLA at 23,764 plants. No new invasive plant populations were found in the 2017 Spruce Lake fire area, but populations of prickly lettuce (*Lactuca serriola*) in previously surveyed areas were found to have expanded in 2022. Approximately 2,660 plants were treated in the 2017 Spruce Lake fire in 2022, which represents a 480% increase from 2021.

Invasive vegetation management within CRLA's wetland and meadow systems was productive this year. Typically, for large portions of the year these areas (e.g., Cottonwood Meadows, Spruce Lake)

contain too much standing water to apply herbicide and as water recedes throughout the season, native vegetation growth is often so dense as to make herbicide application challenging. However, during the 2021 and 2022 field seasons, both Cottonwood Meadows and Spruce Lake were almost entirely dried up. The extremely low water levels made surveying Spruce Lake easier, and spraying Canada thistle in the middle of the dry lakebed was now possible. Treatments in 2021 produced effective results at Spruce Lake as 42% fewer plants were found and treated in 2022. At Cottonwood Meadows, however, a significant amount of time was spent treating white clover (*Trifolium repens*) and common dandelion (*Taraxacum officinale*). Approximately 3,030 invasive plants were treated in Cottonwood Meadows this year resulting in a 344% increase over 2021 numbers.

Poison Meadows continues to be a vulnerable area. Its proximity to heavily invaded meadows of the Rogue River Siskiyou National Forest (RRSNF) combined with the proclivity of wildlife to browse and bed within the tall grass of the meadows make for a constantly changing suite of invasive plant populations. Treatments in 2021 to control populations of sheep sorrel and St. John's wort seemed to be effective as much smaller populations of these species were found in 2022. Numbers of yellow salsify (*Tragopogon dubius*) continue to be high, especially in the meadows closest to the RRSNF boundary. A new infestation of hairy cat's-ear (*Hypochaeris radicata*) was discovered in Poison Meadows in 2022. With this newly discovered invasive plant population, 8,685 invasive plants were controlled in Poison Meadows in 2022, a 42% increase compared to 2021 efforts.



Figure 6. The Botany crew works together to treat a newly discovered infestation of sheep sorrel. Photo by Casey Allen.

Riparian areas surveyed within CRLA in 2022 were Annie Creek, Lower Castle Creek (Figure 7), Crater Creek, National Creek, Pothole Creek, and Sun Creek. Surveys at several sites yielded a

decrease in invasive plant populations compared with 2021 numbers (Table 2). The invasive plant situation at Crater Creek improved with decreasing bull thistle abundance compared with 2021, and the wall lettuce (*Mycelis muralis*) patches that received treatment in 2021 also were reduced in size.

Surveys in Annie Creek continue to detect robust invasive plant populations in 2022. Bull thistle populations increased in size; however, historic sheep sorrel patches returned this year and were treated in their entirety. Follow up surveys later in the 2022 season showed that early-season treatment was effective in controlling sheep sorrel infestations. Overall, invasive plant abundance increased by 560% compared to the 2021 field season.



Figure 7. Several IVM crew members survey the steep meadows above Castle Creek for invasive plants. Photo by Casey Allen.

The steep meadow seeps that drain into Lower Castle Creek host a diversity of native vegetation as well as several nonnative plant species that are found few other places in CRLA such as common mouse-ear chickweed (*Cerastium fontanum* ssp. *vulgare*) and prickly sow thistle (*Sonchus asper*). Populations of bull thistle expanded in Lower Castle Creek in 2022 with 936 plants treated; this population is located on the ridge above the meadow system in a previously burned area.

Table 2. Number of invasive plants treated in the Backcountry Zone from 2018—2022 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Backcountry Zone IVM Region	2022	2021	2020	2019	2018
Annie Creek	2,717	412	279	493	1,092
Blanket Creek Fire	12,152	5,106	13,936	15,200	3,892
Bybee Creek – Lower	*	*	188	4,160	*
Bybee Creek Fire	466	730	704	2,267	626
Castle Creek – Lower	1,023	959	744	1,701	843
Castle Creek – North Fork	*	*	0	*	*
Castle Crest Wildflower Garden	1	3	0	0	*
Castle Fire	11	41	124	226	2,102
Copeland Creek	*	3	*	60	*
Cornerstone Burn Unit	*	0	0	0	*
Crater Creek	550	1,514	30,642	8,881	775
Desert Ridge Fire (NCC)	25	24	110	625	111
Godfrey Glen	*	1	*	*	*
Munson Creek	*	467	*	430	*
National Creek	520	1,036	279	*	241
National Creek Complex	23,764	3,588	432	1,844	1,036
Panhandle – Interior	*	0	0	0	40
Panhandle – Cottonwood Meadow	3,030	682	2,015	3,105	2,552
PH3 Burn Unit	5	10	*	14	14
Poison Meadows	8,685	6,118	4,834	10,068	15,632
Pothole Creek	6	130	0	0	*
Pumice Complex	*	1	3	0	2
Red Blanket Canyon	3,730	791	*	20,857	960
Sand Creek	*	*	0	14	*
Scoria Fire	58	120	39	65	1
Spruce Lake	639	1,104	659	1,013	1,300
Spruce Lake Fire	2,660	459	3,274	2,581	3,008
Sun Creek	157	1,058	0	3,968	2,500
Thousand Springs (North & South)	990	1,374	552	2,876	6,076
Timber Crater	9	3	0	0	*
Upper Panhandle Burn Unit/Baboon	8	3	95	1,120	5,880
Total	61,206	25,734	58,909	81,628	48,683

Table 3. Number of invasive plants treated in the Backcountry Zone from 2018—2022 by plant species. Asterisks (*) denote species that weren't encountered or treated in a particular year.

Plant Species	2022	2021	2020	2019	2018
Redtop (<i>Agrostis gigantea</i>)	*	*	*	72	*
Meadow foxtail (<i>Alopecurus pratensis</i>)	*	*	*	1	*
Yellow rocket (<i>Barbarea vulgaris</i>)	*	4	238	*	*
Smooth brome (<i>Bromus inermis</i>)	*	*	*	*	10
Cheatgrass (<i>Bromus tectorum</i>)	*	*	12	*	*
Common mouse-ear chickweed (<i>Cerastium fontanum</i> ssp. <i>vulgare</i>)	*	324	*	219	*
Canada thistle (<i>Cirsium arvensis</i>)	907	1,046	635	1,113	1,454
Bull thistle (<i>Cirsium vulgare</i>)	6,445	1,311	3,440	13,334	8,396
Tall orchardgrass (<i>Dactylis glomerata</i>)	*	30	*	15	*
St. John's wort (<i>Hypericum perforatum</i>)	365	495	136	704	1,836
Hairy cat's ear (<i>Hypochaeris radicata</i>)	562	56	4	99	127
Tall lettuce (<i>Lactuca canadensis</i>)	10	*	16	41	*
Prickly lettuce (<i>Lactuca serriola</i>)	2,489	728	169	1,228	671
Wall lettuce (<i>Mycelis muralis</i>)	544	1,995	30,040	8,156	399
Reed canarygrass (<i>Phalaris arundinacea</i>)	*	*	*	3,008	1,374
Timothy (<i>Phleum pratense</i>)	*	398	200	943	2,702
Annual bluegrass (<i>Poa annua</i>)	390	*	*	*	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	40	*	*	*	*
Sheep sorrel (<i>Rumex acetosella</i>)	24,442	3,072	838	2,317	4,257
Curly dock (<i>Rumex crispus</i>)	*	*	*	14	*
Tansy ragwort (<i>Senecio jacobaea</i>)	*	1	*	3	421
Woodland groundsel (<i>Senecio sylvaticus</i>)	161	75	5,611	19,957	4,267
Common groundsel (<i>Senecio vulgaris</i>)	1	38	*	*	50
Prickly sow thistle (<i>Sonchus asper</i>)	18	111	104	318	185
Red sand-spurrey (<i>Spergularia rubra</i>)	*	*	*	*	200
Common dandelion (<i>Taraxacum officinale</i>)	5,381	5,665	2,468	13,131	12,274
Yellow salsify (<i>Tragopogon dubius</i>)	6,649	3,427	3,615	5,660	8,337
White clover (<i>Trifolium repens</i>)	111	*	1,099	325	85
Common mullein (<i>Verbascum thapsus</i>)	12,691	6,958	10,484	10,910	1,638

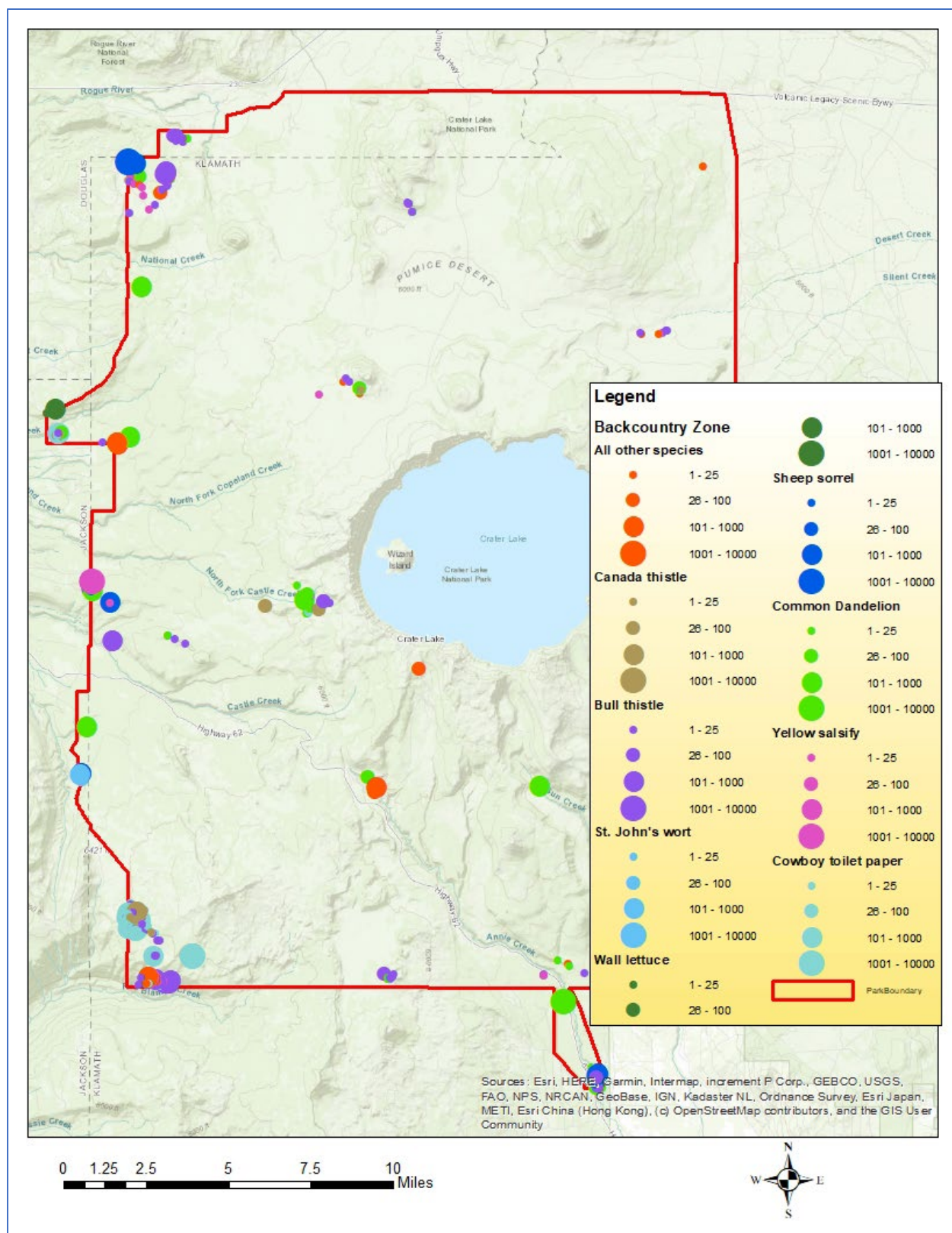


Figure 8. 2022 invasive plant populations in the Backcountry Zone. Map by Hamilton Hasty.

Developed Zone

Crater Lake National Park's developed areas are Rim Village, park headquarters/housing, Mazama Dorms, Mazama Village and Cabins, Mazama Campground, CRLA's two sewage lagoons, water storage areas, and Lost Creek Campground. All areas receive high levels of foot and vehicle traffic and routine maintenance, which are potential vectors for establishment of invasive vegetation. In 2022, 13,205 individuals of 13 different invasive plant species were controlled in CRLA's developed areas (Figure 11). Comparison with findings from the 2018 - 2022 field seasons are made in Tables 4 and 5. The decrease in total numbers of invasive plants treated in the Developed Zone in 2022 was primarily due to consistent herbicide treatment of sheep sorrel, red sand-spurrey (*Spergularia rubra*) and common knotweed (*Polygonum aviculare* ssp. *depressum*).

Most invasive plants in CRLA's developed areas were found at Rim Village, with significant infestations at park headquarters/housing (Figure 10) and near Mazama Village as well. Across all developed areas, common knotweed (*Polygonum aviculare* ssp. *depressum* – Figure 9), sheep sorrel, and red sand-spurrey were the most frequently encountered invasive plant species. These species thrive in compacted soils and pavement crevices found throughout the developed zone.



Figure 9. Common knotweed spreading widely after establishing in pavement cracks in the park housing area. Photo by Hamilton Hasty.

Yellow rocket (*Barbarea vulgaris*) has experienced a decrease in population size over the years and only 21 individuals were encountered and treated in 2022. A new species to CRLA was encountered at Rim Village in 2022. One individual of bullhead (*Tribulus terrestris*) was found and treated.

No invasive plant species were found growing where extensive hazard tree removal work occurred in Mazama Campground. None of the Alternative Forest Management fuel break project areas away from the road prisms along Highway 62, Mazama Village, and Munson Valley have been colonized by invasive plant species; however, follow-up surveys will occur for the next two years.



Figure 10. An IVM crew member treats nonnative plants with herbicide in the park housing area. Photo by Casey Allen.

There has been a steady reduction in the size of sheep sorrel populations within the Developed Zone. The largest population has historically been in the meadows east of the Crater Lake Lodge. In 2020 the sheep sorrel population consisted of approximately 1,300 plants, all of which were treated with herbicide. In 2021 that same population numbered approximately 995 plants, a 23% reduction in population size. In 2022 the population numbered 736 plants, a 26% reduction in population size. This population was also treated in its entirety in 2022.

Table 4. Number of invasive plants treated in the Developed Zone from 2018-2022 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Developed Zone IVM Region	2022	2021	2020	2019	2018
Headquarters/Housing	867	3,770	7,728	4,908	3,797
Lost Creek Campground	0	48	0	0	0
Mazama Campground	2,825	1,743	0	629	118
Mazama Dorms	201	304	174	43	3
Mazama Village	2,916	2,685	167	2,450	51
Rim Village	6,396	27,012	33,026	75,872	14,708
Total	13,205	35,562	41,095	83,902	18,677

Table 5. Number of invasive plants treated in the Developed Zone from 2018-2022 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2022	2021	2020	2019	2018
Browntop (<i>Agrostis capillaris</i>)	35	*	*	*	*
Redtop (<i>Agrostis gigantea</i>)	109	15	282	*	*
Meadow Foxtail (<i>Alopecurus pratensis</i>)	*	*	*	5	30
Yellow rocket (<i>Barbarea vulgaris</i>)	21	24	213	311	175
Smooth brome (<i>Bromus inermis</i>)	*	45	30	484	*
Cheatgrass (<i>Bromus tectorum</i>)	*	*	1	*	*
Diffuse knapweed (<i>Centaurea diffusa</i>)	*	1	*	*	*
Rush skeletonweed (<i>Chondrilla juncea</i>)	*	*	*	1	*
Chicory (<i>Cichorium intybus</i>)	*	*	*	1	*
Common hound's tongue (<i>Cynoglossum officinale</i>)	*	*	*	1	*
Tall orchardgrass (<i>Dactylis glomerata</i>)	*	1	*	*	1
St. John's wort (<i>Hypericum perforatum</i>)	2	*	11	1	9
Hairy cat's-ear (<i>Hypochaeris radicata</i>)	1	*	*	*	*
Stinking pepperweed (<i>Lepidium ruderales</i>)	*	*	*	19	*
Birdsfoot trefoil (<i>Lotus corniculatus</i>)	*	*	*	*	*
Pineapple weed (<i>Matricaria discoidea</i>)	*	6	7	582	1,615
Yellow sweet clover (<i>Melilotus officinalis</i>)	*	*	*	1	*
Timothy (<i>Phleum pratense</i>)	*	2	*	*	*
English plantain (<i>Plantago lanceolata</i>)	*	2	2	3	1
Common plantain (<i>Plantago major</i>)	27	10	*	6	2
Annual bluegrass (<i>Poa annua</i>)	*	1,316	113	351	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	1	*	161	*	*
Canada bluegrass (<i>Poa compressa</i>)	*	*	*	*	250
Common knotweed (<i>Polygonum aviculare</i> ssp. <i>depressum</i>)	4,449	6,212	2,598	6,180	305
Sheep sorrel (<i>Rumex acetosella</i>)	808	2,041	3,427	1,991	7,288
Curly dock (<i>Rumex crispus</i>)	*	1	*	*	*
Woodland groundsel (<i>Senecio sylvaticus</i>)	*	6	*	*	*
Red sand-spurrey (<i>Spergularia rubra</i>)	7,634	25,510	34,126	73,236	8,103
Common dandelion (<i>Taraxacum officinale</i>)	116	273	109	600	294
Yellow salsify (<i>Tragopogon dubius</i>)	1	1	*	*	1
Bullhead (<i>Tribulus terrestris</i>)	1	*	*	*	*
Dutch clover (<i>Trifolium repens</i>)	*	95	1	*	*
Common mullein (<i>Verbascum thapsus</i>)	*	1	*	*	*

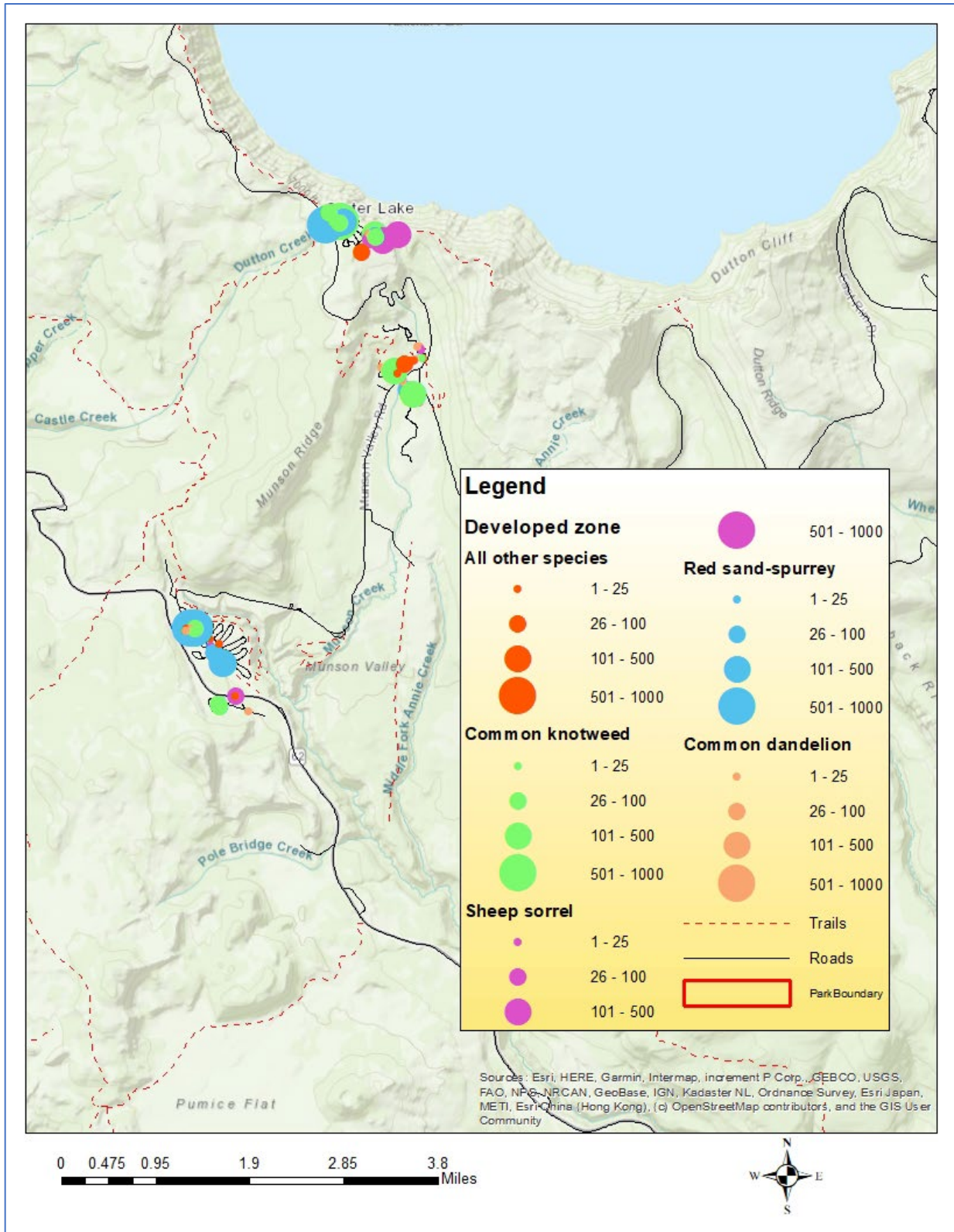


Figure 11. 2022 invasive plant populations in the Developed Zone. Map by Hamilton Hasty.

Lakeshore Zone

The shore of Crater Lake is the most difficult region of CRLA for survey and treatment of invasive plant species. Access to most of the lakeshore is restricted by snowpack, the water level of the lake, and the limited ability of the Lake crew to shuttle the IVM crew from site to site. Timing is also paramount for the treatment of perennial or rhizomatous invasive plants to be effective. In 2022, the IVM crew spent four days surveying the lakeshore including Wizard Island (Figure 12) and Phantom Ship. Surveys detected 2,125 individuals of 11 invasive plant species in five different areas along the lakeshore (Tables 6-7, Figure 14).



Figure 12. An IVM crew member surveys Wizard Island for invasive plants. Photo by Brian Pitt.

Historically, the Watchman Bench area of the “Discovery Point to Merriam Point” region contains the largest diversity and number of invasive plant species along the lakeshore as well as some of the most persistent invasive plant populations (Figure 13). This year, however, only 178 invasive plants were found in this region, which is markedly fewer than those found in 2021. Only four common mullein individuals were found, which is a 50% decline from 2021; and 130 individuals of Canada thistle were found in 2022, which is similar to the 113 Canada thistle individuals found in 2021. Both the common mullein and Canada thistle populations along the bench have persevered through

consistent treatment for over a decade. Populations of common groundsel (*Senecio vulgaris*) and woodland groundsel (*Senecio sylvaticus*) along the Watchman Bench experienced marked decreases this year with only 16 common groundsel plants found (compared to 442 plants in 2021) and no common groundsel plants encountered in 2022 compared with 856 plants found in 2021.

Unfortunately, cheatgrass was detected growing around the Wineglass area where it was previously discovered in 2019 (Table 7). Prickly sow thistle continues to be found along the lakeshore after its discovery in 2019, but has slightly decreased in abundance since 2021. Phantom Ship was surveyed, and no invasive plants were encountered this year.



Figure 13. Left: An IVM crew member double-checks a data entry point in the Watchman Bench area. Right: An IVM crew member treats Canada thistle in the Watchman Bench area. Photos by Hamilton Hasty.

The greatest abundance of invasive plants encountered along the lakeshore in 2022 was within the ‘Skell Head to Eagle Point’ and the Wizard Island regions. In the ‘Skell Head to Eagle Point’ region alone, 932 nonnative plants were encountered and treated where none had been detected in previous years. This was due to a large population of common groundsel that established on the lakeshore near Phantom Ship. Wizard Island similarly showed a 680% increase in invasive plants encountered from 2021 to 2022 due to an increase in numbers of common groundsel plants.

Time spent by the IVM crew on the lakeshore during the 2020 field season was extremely limited in time and resources due to limitations caused by the COVID-19 pandemic. This year the IVM crew

was able to perform a complete survey of all the lakeshore regions, excepting the “Merriam Point to Cleetwood Cove” region which is difficult to survey due to abundant cliffs and the need for dedicated Lake crew assistance to shuttle IVM staff around. These factors combined with low water levels resulted in a significantly higher number of invasive plants discovered and controlled on the lakeshore than over the past four years combined.

Table 6. Number of invasive plants treated in the Lakeshore Zone from 2018-2022 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Lakeshore Zone IVM Region	2022	2021	2020	2019	2018
Cleetwood Cove to Skell Head	337	235	38	28	117
Skell Head to Eagle Point	932	*	*	*	0
Eagle Point to Discovery Point	45	21	*	*	0
Discovery Point to Merriam Point	178	1,595	16	156	469
Merriam Point to Cleetwood Cove	*	*	*	*	*
Phantom Ship	0	1	*	*	*
Wizard Island	633	81	*	14	0
Total	2,125	1,933	54	198	586

Table 7. Number of invasive plants treated in the Lakeshore Zone from 2018-2022 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2022	2021	2020	2019	2018
Cheatgrass (<i>Bromus tectorum</i>)	3	*	*	8	*
Canada thistle (<i>Cirsium arvensis</i>)	258	126	13	103	2
Bull thistle (<i>Cirsium vulgare</i>)	14	55	*	11	*
St. John's wort (<i>Hypericum perforatum</i>)	*	6	*	*	408
Hairy cat's ear (<i>Hypochaeris radicata</i>)	7	100	2	15	*
Prickly lettuce (<i>Lactuca serriola</i>)	8	22	*	*	*
Wall lettuce (<i>Mycelis muralis</i>)	2	2	*	3	*
Kentucky bluegrass (<i>Poa pratensis</i>)	*	*	*	*	16
Sheep sorrel (<i>Rumex acetosella</i>)	*	*	*	*	144
Tansy ragwort (<i>Senecio jacobea</i>)	*	*	*	2	*
Woodland groundsel (<i>Senecio sylvaticus</i>)	*	859	*	21	*
Common groundsel (<i>Senecio vulgaris</i>)	1,779	723	36	*	*
Prickly sow thistle (<i>Sonchus asper</i>)	3	4	*	1	*
Red sand-spurrey (<i>Spergularia rubra</i>)	*	1	*	*	*
Common dandelion (<i>Taraxacum officinale</i>)	27	18	*	19	16
Yellow salsify (<i>Tragopogon dubius</i>)	20	9	3	1	*
Common mullein (<i>Verbascum thapsus</i>)	4	8	*	14	*

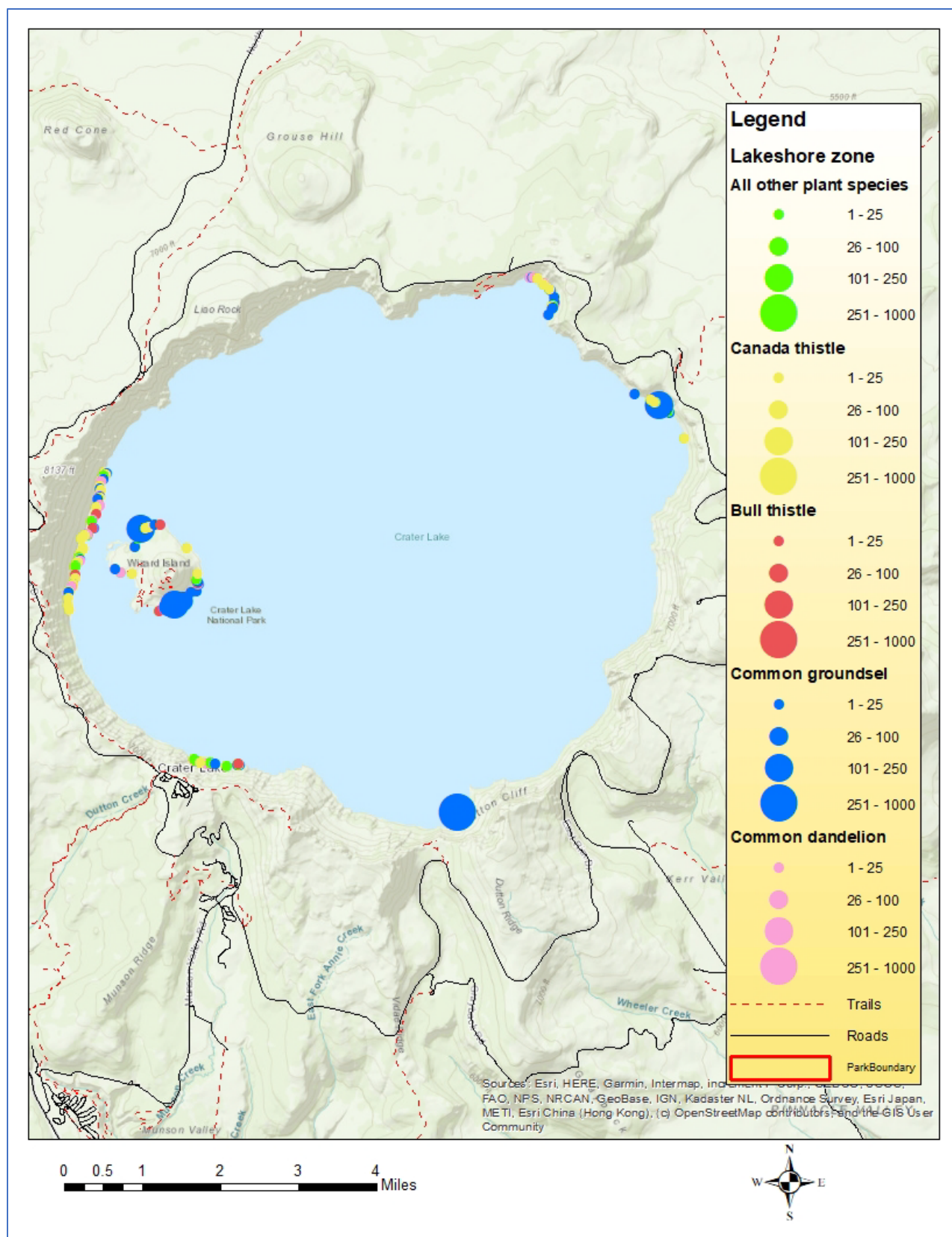


Figure 14. 2022 invasive plant populations in the Lakeshore Zone. Map by Hamilton Hasty.

Roadside Zone

Crater Lake National Park roads include Highway 62 (Figure 15), Munson Valley Road, West and East Rim Drives, Pinnacles Road, Grayback Road, North Entrance Road, and Highway 138. A high diversity and density of invasive plants in CRLA are found along roadsides, as roads serve as conduits for invasive plant introduction and their constant maintenance creates ground disturbance that exacerbates their establishment and spread. In 2022, all roads within CRLA were surveyed for invasive plant species. No invasive species were found or treated on Pinnacles Road in 2022, and Grayback Road (closed to public motor vehicle use) continues to remain free of invasive plant species. Twenty-six invasive plant species, totaling 10,013 individual plants, were treated along roadsides in 2022. Comparisons of roadside IVM regions surveyed and invasive plant species found during the 2018 to 2022 field seasons are listed in Tables 8 and 9. Roadside locations of invasive plant species encountered in 2022 are displayed in Figure 17.



Figure 15. The IVM crew surveys for invasive plants along west Highway 62. Photo by Javonn Sims.

Highway 62, Highway 138, and Munson Valley Road are early season priorities since they continue to maintain considerable infestations and are among the first sections of CRLA to melt out in late spring. Highway 62, especially the section from the PCT trailhead to the southern CRLA boundary, contains some of the largest and most abundant infestations of invasive plant species. Highway 138, a heavily trafficked route along the northern boundary of CRLA, has historically supported a diversity of invasive plant species (generally in small numbers), several of which have been found nowhere else in CRLA. Infestations along Munson Valley Road are concentrated near developed areas (Mazama Village, pullouts, and park headquarters) where there is high visitor traffic.

The southernmost section of Highway 62 in the Panhandle region of CRLA continues to sustain sizable populations of bulbous bluegrass (*Poa bulbosa*), with scattered small populations extending up to Munson Valley Road as well. Bulbous bluegrass reproduces through viviparous bulblets formed in the flowers, although some populations do not produce viviparous bulblets in the inflorescence. Bulbous bluegrass populations can contain both viviparous and seed-producing plants admixed (Meyers et al. 2015). This species is targeted for control in May as plants are starting to flower. The small plants are easily removed by hand-pulling, taking care to ensure all stem bulbs are dug up and removed from the site (Figure 16). Early control is important to prevent bulbous bluegrass from becoming a widespread invader at CRLA, as this species is a prolific weed in many western states (Scheinost et al. 2008).



Figure 16. Left: An IVM crew member manually removes an invasive plant from alongside Highway 62. Photo by Hamilton Hasty. Right: An IVM crew member collects data along Highway 62. Photo by Casey Allen.

Rim Drive continues to contain localized infestations of invasive plant species with portions of these roads found to be weed-free. Four years after the massive disturbance caused by Phase I of the Rim Drive Rehabilitation project, few invasive plants were encountered immediately along the roadside. The road shoulder in this project was subject to a “shoulder-backing” treatment, where fill was applied and compacted to meet the pavement edge. These shoulder-backed edges should be watched carefully for invasive plant establishment, as they are receptive to colonizing vegetation. The North Entrance Road is often sparsely colonized by invasive plants. Very few infestations have been found along this road in the past; in 2021, new infestations of diffuse knapweed (*Centaurea diffusa*) and spotted knapweed (*Centaurea stoebe* ssp. *micranthos*) were present, but these plant species were not found in 2022. Since 2015, the Pumice Desert overlook along the North Entrance Road has continued to support small invasive plant infestations of pepperweed (*Lepidium* sp.) and field bindweed (*Convolvulus arvensis*) after the area was used to stockpile gravel “chips” for a pavement preservation project in 2014. The field bindweed was not encountered in 2022.

Sheep sorrel, common dandelion, and St. John’s wort are early season targets for herbicide treatment along roadsides (Figure 18). Sheep sorrel and common dandelion have persistent roots (rhizomes and taproots, respectively) and are among the first species to flower and fruit, making early chemical treatment essential. Populations of St. John’s wort within CRLA boundaries continue to be well below the peak of over 18,000 plants in 2006. In 2022, 285 individual St. John’s wort plants were treated along roadsides, even as dense stands of St. John’s wort continue to line the highways and U.S. Forest Service roads just west of CRLA.

Smooth brome remains persistent; however, this species has generally declined in abundance over recent years. This species can usually be found near Mazama Village, along Highway 62, and along Munson Valley Road. Ninety-eight individuals were treated in 2022, all of which were found along Munson Valley Road. The proximity of some populations to the entrance station and Annie Creek Restaurant restricts timing for herbicide treatment, and the section behind the guardrails on west Highway 62 is usually the densest section that can easily escape detection.

Several populations of cheatgrass were discovered along Highway 62 south of the park entrance and along Highway 138 in 2020. In 2022 only two cheatgrass individuals were found along roadsides, one on Highway 138 and the other on Highway 62. Future surveys should continue to keep a close eye on these populations returning. Well-established and abundant populations of other nonnative grasses, including Kentucky bluegrass (*Poa pratensis*), Canada bluegrass (*Poa compressa*), and colonial bentgrass (*Agrostis capillaris*) are only occasionally treated, and usually only when they threaten habitat for rare or sensitive plants or habitats. These three species were not treated in 2022.

There were two newly discovered invasive plant species to CRLA discovered this year along roadsides: Jim Hill mustard (*Sisymbrium altissimum*) and alfalfa (*Medicago sativa*). Four individuals of Jim Hill mustard were found along East Rim Drive. This species has basal and cauline leaves, with the basal and proximal cauline leaves being pinnately lobed. It has pale yellow flowers, with sepals that are horned at the tip. Only one alfalfa plant was found growing along Highway 138. This is a perennial species in the legume family, distinguished by its trifoliate leaves and clusters of purple

flowers. The seedpods of this plant spiral in two to three turns. Dog fennel (*Anthemis cotula*), which was a newly discovered nonnative plant species in 2021, was not found in 2022.

Table 8. Number of invasive plants treated in the Roadside Zone from 2018-2022 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Roadside Zone IVM Region	2022	2021	2020	2019	2018
East Rim Drive	218	4,339	327	883	170
Highway 138	1,592	417	852	3,793	4,260
Munson Valley Road	1,606	4,427	1,387	1,966	3,547
North Entrance Road	21	37	9	149	0
Pinnacles Road	0	0	0	0	*
South Highway 62	4,307	3,806	8,637	5,517	11,723
West Highway 62	2,122	905	958	2,063	1,042
West Rim Drive	147	0	0	37	1
Total	10,013	13,931	12,170	14,408	20,967

Table 9. Number of invasive plants treated in the Roadside Zone from 2018-2022 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2022	2021	2020	2019	2018
Colonial bentgrass (<i>Agrostis capillaris</i>)	3	*	*	421	10
Redtop (<i>Agrostis gigantea</i>)	40	*	*	*	15
Meadow foxtail (<i>Alopecurus pratensis</i>)	*	*	6	1	83
Desert Alyssum (<i>Alyssum desertorum</i>)	7	*	46	38	*
Dog-fennel (<i>Anthemis cotula</i>)	*	1	*	*	*
Tall oatgrass (<i>Arrhenatherum elatius</i> var. <i>elatius</i>)	*	*	*	*	1
Yellow rocket (<i>Barbarea vulgaris</i>)	5	5	2	4	2
Canola (<i>Brassica napus</i>)	*	*	2	*	*
Field mustard (<i>Brassica rapa</i>)	*	*	*	*	1
Smooth brome (<i>Bromus inermis</i>)	98	32	344	687	731
Cheatgrass (<i>Bromus tectorum</i>)	2	2	884	*	301
Diffuse knapweed (<i>Centaurea diffusa</i>)	*	1	*	*	*
Spotted knapweed (<i>Centaurea stoebe</i> ssp. <i>micranthos</i>)	3	7	*	21	12
Lamb's quarters (<i>Chenopodium album</i>)	*	*	*	*	3
Rush skeletonweed (<i>Chondrilla juncea</i>)	*	*	4	1	2
Chicory (<i>Cichorium intybus</i>)	*	*	*	1	*
Canada thistle (<i>Cirsium arvensis</i>)	*	*	*	1	1
Bull thistle (<i>Cirsium vulgare</i>)	*	*	*	2	*
Field bindweed (<i>Convolvulus arvensis</i>)	*	*	4	3	9

Plant Species	2022	2021	2020	2019	2018
Tall orchardgrass (<i>Dactylis glomerata</i>)	*	*	*	10	*
Feather geranium (<i>Dysphania botrys</i>)	1,751	*	*	47	*
Quackgrass (<i>Elymus repens</i>)	128	*	*	422	*
Red fescue (<i>Festuca rubra</i>)	*	*	*	50	*
St. John's wort (<i>Hypericum perforatum</i>)	286	659	547	592	298
Hairy cat's ear (<i>Hypochaeris radicata</i>)	1	*	2	1	1
Prickly lettuce (<i>Lactuca serriola</i>)	8	*	*	3	*
Field pepperweed (<i>Lepidium campestre</i>)	*	*	*	*	16
Purple anther field pepperweed (<i>Lepidium heterophyllum</i>)	*	2	*	237	197
Narrow-leaved peppergrass (<i>Lepidium ruderale</i>)	5	*	*	*	*
Oxeye daisy (<i>Leucanthemum vulgare</i>)	12	3	7	*	7
Pineapple weed (<i>Matricaria discoidea</i>)	*	*	*	*	*
Alfalfa (<i>Medicago sativa</i>)	1	*	*	*	*
Reed canarygrass (<i>Phalaris arundinacea</i>)	*	*	*	*	12
Timothy (<i>Phleum pratense</i>)	15	3	*	9	15
English plantain (<i>Plantago lanceolata</i>)	28	16	1	32	3
Common plantain (<i>Plantago major</i>)	1	2	*	*	1
Annual bluegrass (<i>Poa annua</i>)	*	*	100	*	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	1,898	1,669	4,275	2,616	6,423
Canada bluegrass (<i>Poa compressa</i>)	*	*	*	320	267
Kentucky bluegrass (<i>Poa pratensis</i>)	*	16	38	*	1,788
(<i>Polygonum aviculare</i> ssp. <i>depressum</i>)	*	1,009	*	3	*
Sheep sorrel (<i>Rumex acetosella</i>)	4,773	7,749	4,676	6,464	6,954
Woodland groundsel (<i>Senecio sylvaticus</i>)	3	*	1	*	5
Common groundsel (<i>Senecio vulgaris</i>)	*	1	*	*	*
Tall Fescue (<i>Schendonorus arundinaceus</i>)	*	*	*	38	*
Jim Hill mustard (<i>Sisymbrium altissimum</i>)	4	*	*	*	*
Red sand-spurrey (<i>Spergularia rubra</i>)	*	1,100	*	10	28
Common tansy (<i>Tanacetum vulgare</i>)	*	*	*	*	1
Dandelion (<i>Taraxacum officinale</i>)	859	1,445	1,142	2,240	3,358
Pubescent wheatgrass (<i>Thinopyrum intermedium</i>)	*	*	*	*	75
Yellow salsify (<i>Tragopogon dubius</i>)	72	72	82	74	99
Red clover (<i>Trifolium pratense</i>)	*	1	*	*	*
White clover (<i>Trifolium repens</i>)	3	133	*	54	30
Common mullein (<i>Verbascum thapsus</i>)	7	3	7	6	37

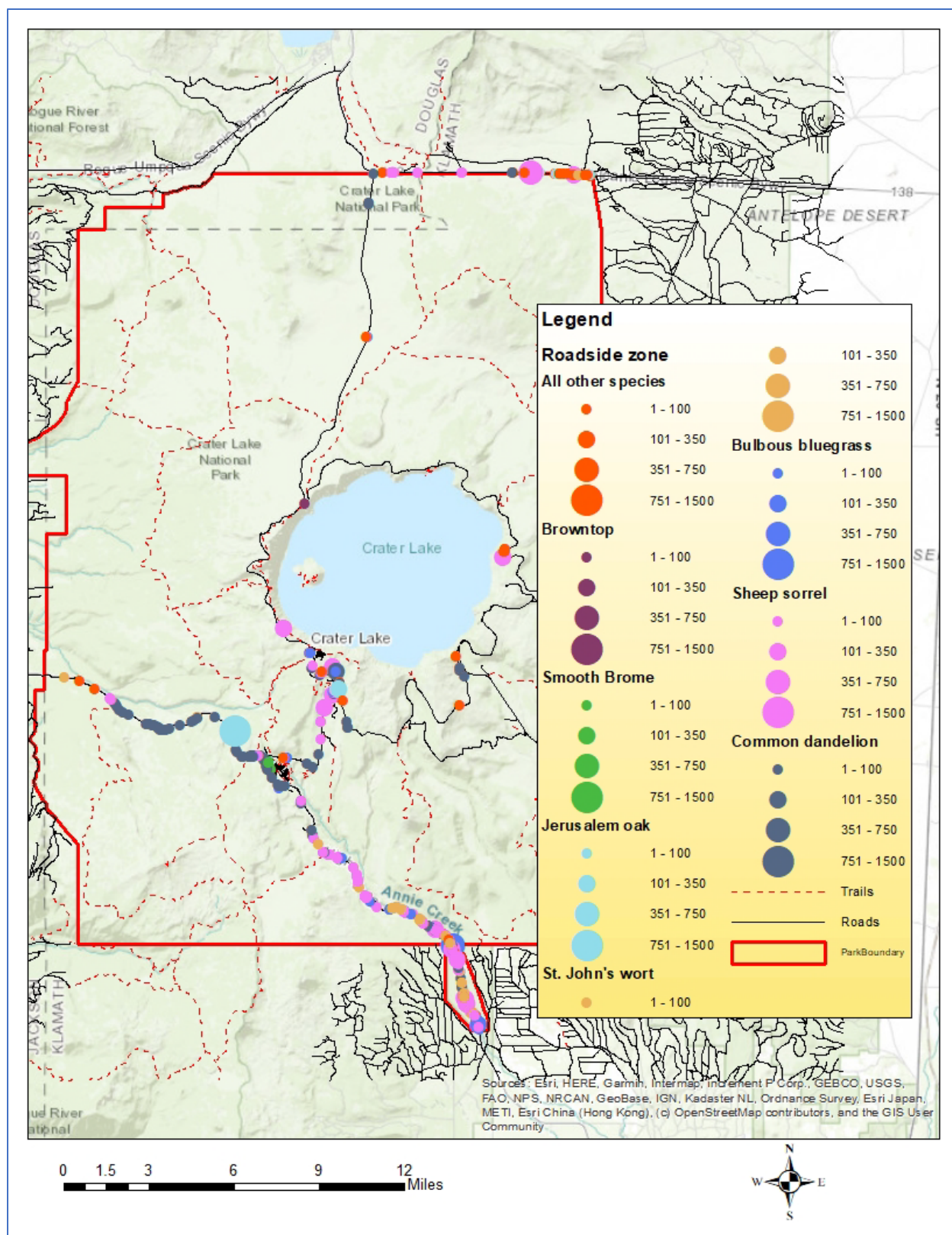


Figure 17. 2022 invasive plant populations in the Roadside Zone. Map by Hamilton Hasty.

Staging Areas Zone

Crater Lake National Park has six staging areas. These include four historic quarries (Pole Bridge Creek Quarry, Watchman Quarry, Anderson Quarry, and Roundtop Quarry) and two maintenance yards (South Yard and the Ball Diamond) that are used for staging and storage of materials, vehicles, and equipment. Due to the active nature of these places, and to the fact that materials stored here can originate from outside CRLA and move freely within the park, it is vital that the IVM program keeps these areas as free of invasive plants as possible. Staging area invasive plant locations encountered in 2022 are displayed in Figure 19. Comparisons with findings from the 2018 to 2022 field seasons are made in Tables 10 and 11.



Figure 18. An individual St. John's wort plant experiencing chlorosis after herbicide treatment. Photo by Hamilton Hasty.

In 2022, invasive plants were encountered at two of the six staging areas: Pole Bridge Creek Quarry and the Ball Diamond. A total of 724 invasive plants were treated comprised of six invasive plant species: hairy bittercress, creeping yellow wood sorrel, sulfur cinquefoil, St. John's wort, red sand-spurrey, and common dandelion. No invasive plants were found at Anderson Quarry, Watchman Quarry, Roundtop Quarry, and South Yard.

Red sand-spurrey was the most abundant invasive plant species encountered in these areas. Populations have increased in size since the 2021 field season. These areas should be monitored in future field seasons to prevent spread of this invasive plant to other areas of CRLA. Sulfur

cinquefoil was discovered at Pole Bridge Creek Quarry in 2020, and was found again in 2022. St. John's wort was found at Pole Bridge Creek Quarry. Hairy bittercress and creeping yellow wood sorrel were discovered at the Ball Diamond after arriving in containerized plants received from a partner nursery. Any plant shipments received from outside of CRLA need to be thoroughly checked for hitchhiking invasive plant species, and if possible, a waiting period of one year should elapse prior to outplanting nursery stock within CRLA.

Table 10. Number of invasive plants treated in the Staging Area Zone from 2018-2022 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Staging Area Zone IVM Region	2022	2021	2020	2019	2018
Anderson Quarry	0	1	0	7	47
Ball Diamond	492	340	50	*	0
Pole Bridge Creek Quarry	91	14	45	100	9
Roundtop Quarry	0	0	0	0	0
South Yard	0	8	5	52	5
Watchman Quarry	0	0	0	0	0
Total	633	363	100	159	61

Table 11. Number of invasive plants treated in the Staging Area Zone from 2018-2022 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2022	2021	2020	2019	2018
Yellow rocket (<i>Barbarea vulgaris</i>)	*	2	4	107	9
Smooth brome (<i>Bromus inermis</i>)	*	*	*	*	*
Hairy bittercress (<i>Cardamine hirsuta</i>)	50	35	*	*	*
Bull thistle (<i>Cirsium vulgare</i>)	*	*	*	*	1
St. John's wort (<i>Hypericum perforatum</i>)	2	*	8	*	*
Rough cat's ear (<i>Hypochaeris radicata</i>)	*	1	*	*	*
Yellow sweetclover (<i>Melilotus officinalis</i>)	*	*	*	45	*
Creeping yellow wood sorrel (<i>Oxalis corniculata</i>)	50	*	*	*	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	*	*	*	*	*
Sulfur cinquefoil (<i>Potentilla recta</i>)	88	*	20	*	*
Red sand-spurrey (<i>Spergularia rubra</i>)	442	304	50	*	*
Common dandelion (<i>Taraxacum officinale</i>)	1	13	13	*	*
Yellow salsify (<i>Tragopogon dubius</i>)	*	5	1	6	2
Common mullein (<i>Verbascum thapsus</i>)	*	3	4	1	2

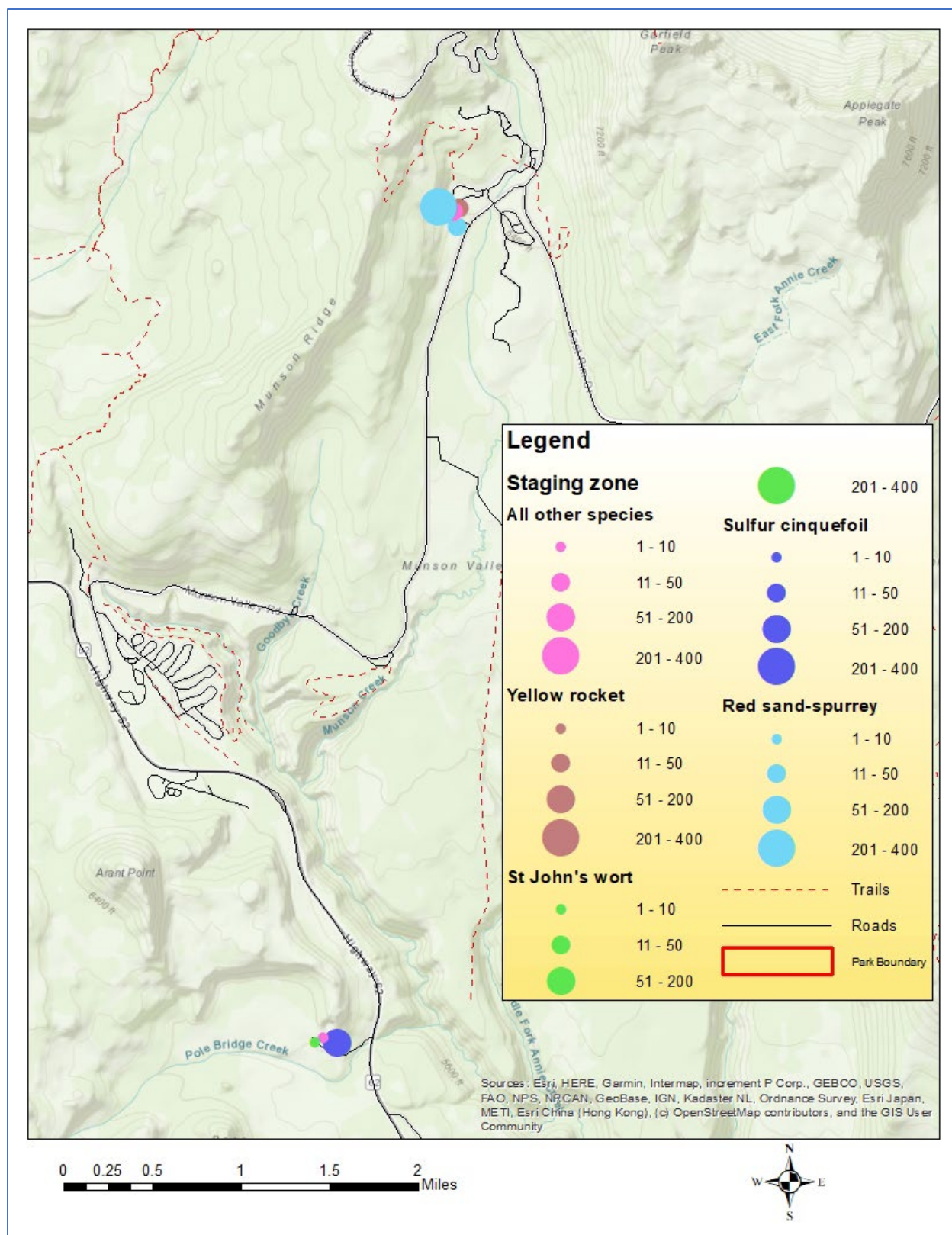


Figure 19. 2022 invasive plant populations in the Staging Areas Zone. Map by Hamilton Hasty.

Discussion

In 2022 efforts continued to mitigate the impacts of large construction and rehabilitation projects occurring throughout CRLA. An increase in invasive plants was detected along West Rim Drive this season. As the Rim Drive Rehabilitation project progresses it will become increasingly important to continue monitoring for invasive species along West and East Rim Drives especially as efforts continue to revegetate disturbed areas. The Wildfire Risk Reduction (previously named Active Forest Management) project work continued along south Highway 62, Mazama Village, and Munson Valley with additional piles being burned this season; new piles were created along the North Entrance Road. Surveys in following years should focus on the areas where pile burning has occurred and will occur to prevent any invasive species from becoming established in these recently disturbed areas. Highway 138 experienced roadside grading in 2020 and 2021 by the Oregon Department of Transportation, which completely displaced vegetation within this corridor. This resulted in invasive plant surveys in spring and early summer yielding few invasive plant species in 2021, but in 2022 these numbers seemed to have returned. Cheatgrass was found in low numbers this year, but all historic population sites should be checked again next season.

The 2022 field season had two backcountry camping trips scheduled this year but one at the Blanket Creek Fire was cancelled due to illness in the crew. Despite this the crew was able to treat large infestations of common mullein including the massive populations on the eastern side of this fire. In future years, backcountry camping trips are recommended for the upper part of this fire as well as in the lower Red Blanket Canyon. Taking on additional staff, conservation crews, or volunteers in these areas would be ideal to treat the large infestations of common mullein.

The Crater Creek wall lettuce population responded well to herbicide treatment in 2020 and continued treatment in 2021; if time allows, another treatment should be conducted in the future. The wall lettuce at this site seems to be becoming more manageable over time with consistent treatments. Large sheep sorrel populations discovered in the 2015 National Creek Complex will need be followed up on with treatment, preferably herbicide treatments; herbicide treatments were limited due to multiple weeks of thunderstorms in the area in 2022. The 2015 National Creek Complex will need continual surveys in future years because of the new invasive plant populations that were discovered this season. Additionally, sheep sorrel patches at Poison Meadows and Annie Creek will need to be kept up with in future seasons to ensure they do not get out of control.

The lakeshore common groundsel populations will need annual control to prevent the populations from expanding. Due to these large infestations much time and effort should be spent at the 'Discovery Point to Merriam Point' section of the lakeshore. Additionally, the 'Eagle Point to Discovery Point' region should also be a high priority in future seasons. The new infestation of common groundsel found in this region was surprisingly large with many smaller populations being found, as well.

In developed areas, common knotweed needs to be a high priority. Though populations appear to have decreased, the populations are persistent and small plants grow out of cracks in the pavement which makes them hard to find. Due to this, it is possible plants were overlooked in previous seasons

causing the populations to explode. Taking special care to look in all pavement crevices will be necessary to control common knotweed and keep population numbers down. Since numbers are still low enough to facilitate control, knotweed control should take priority over red sand-spurrey control in these areas.

Lastly, four new nonnative plant species have been introduced to CRLA along roadsides, staging areas, and within the developed zone. These are areas highly trafficked by vehicles and visitors. Extensive surveys should continue in these areas with careful examination of unknown plants to identify any potential new species being introduced to CRLA.

Additional recommendations for IVM work in 2023 include:

- Early testing of field data entry will be needed to ensure the data collection work flow is successful due to new NPS tablet security requirements.
- Expend extra effort surveying the ‘Cleetwood Cove to Skell Head’ region along the lakeshore to continue to search for any possible cheatgrass populations. An effort should be made to survey as far up and out from the lakeshore as possible and continue surveys on the caldera rim above the infestation point.
- Make sure to abide by the lepidopteran treatment avoidance areas at Poison Meadows and Munson Creek. Including these areas in the Field Maps project was helpful in 2022 and should be continued in future years.
- Frequent and thorough surveys of all meadows in the Poison Meadows area are necessary. This area has had large, established, and diverse populations of invasive plant species including sheep sorrel and St. John’s wort.
- Crater Creek experienced a significant increase in wall lettuce in 2020. Efforts should continue to be made to check the infestation in 2023 and expand surveys in search of more infestations.
- The 2015 National Creek Complex harbored two new large invasive plant infestations in 2022 and efforts in 2023 should focus on these infestations. The sheep sorrel will need a control strategy in coming seasons.
- Take extra time to train people on field data entry individually, and make sure they are well-versed in IVM Regions and carry the IVM Region list with them in the field. Double-check the Field Maps project each week for accuracy, as entering the wrong IVM Region is the most common data entry error.
- Ensure unknown plant data forms are complete and that crew members are given the time and encouragement to properly identify specimens.
- Perform bi-weekly data quality control checks when the data are uploaded, and herbicide record forms are updated.
- If able, plan backcountry camping trips early in the season to ensure administrative staff can establish travel-related accounts in time.
- Continue to survey for and manually treat desert alyssum at the Ponderosa Pine Picnic Area in early May.
- Continue to walk West and East Rim Drives to survey for invasive plant establishment.

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Appendix A: Crater Lake National Park Invasive Plant Taxa List by Management Priority

Family	Scientific Name	Common Name	Priority	Strategy
Brassicaceae	<i>Alyssum desertorum</i>	Desert alyssum	1_High	Eradication
Asteraceae	<i>Anthemis cotula</i>	Dog-fennel	1_High	Eradication
Poaceae	<i>Bromus inermis</i>	Smooth brome	1_High	Reduction
Poaceae	<i>Bromus tectorum</i>	Cheatgrass	1_High	Eradication
Brassicaceae	<i>Cardamine hirsuta</i>	Hairy bittercress	1_High	Eradication
Asteraceae	<i>Centaurea diffusa</i>	Diffuse knapweed	1_High	Eradication
Asteraceae	<i>Centaurea stoebe ssp. micranthos</i>	Spotted knapweed	1_High	Eradication
Asteraceae	<i>Chondrilla juncea</i>	Rush skeletonweed	1_High	Eradication
Asteraceae	<i>Cirsium arvense</i>	Canada thistle	1_High	Reduction
Asteraceae	<i>Cirsium vulgare</i>	Bull thistle	1_High	Reduction
Convolvulaceae	<i>Convolvulus arvensis</i>	Field bindweed	1_High	Eradication
Amaranthaceae	<i>Dysphania botrys</i>	Feather geranium	1_High	Eradication
Hypericaceae	<i>Hypericum perforatum</i>	Common St. John's wort	1_High	Reduction
Brassicaceae	<i>Isatis tinctoria</i>	Dyers woad	1_High	Eradication
Asteraceae	<i>Leucanthemum vulgare</i>	Ox-eye daisy	1_High	Reduction
Fabaceae	<i>Medicago sativa</i>	Alfalfa	1_High	Eradication
Oxalidaceae	<i>Oxalis corniculata</i>	Creeping yellow wood sorrel	1_High	Eradication
Poaceae	<i>Phalaris arundinacea</i>	Reed canarygrass	1_High	Eradication
Poaceae	<i>Poa bulbosa</i>	Bulbous bluegrass	1_High	Containment
Rosaceae	<i>Potentilla recta</i>	Erect cinquefoil	1_High	Eradication
Polygonaceae	<i>Rumex acetosella</i>	Sheep sorrel	1_High	Containment
Asteraceae	<i>Senecio jacobaea</i>	Stinking willie	1_High	Eradication
Brassicaceae	<i>Sisymbrium altissimum</i>	Jim Hill mustard	1_High	Eradication
Asteraceae	<i>Tragopogon dubius</i>	Yellow salsify	1_High	Containment
Zygophyllaceae	<i>Tribulus terrestris</i>	Bullhead	1_High	Eradication
Scrophulariaceae	<i>Verbascum thapsus</i>	Common mullein	1_High	Reduction
Poaceae	<i>Anthoxanthum odoratum</i>	Sweet vernalgrass	2_Medium	Eradication
Asteraceae	<i>Arctium minus</i>	Common burdock	2_Medium	Eradication
Poaceae	<i>Arrhenatherum elatius var. elatius</i>	Tall oatgrass	2_Medium	Eradication
Brassicaceae	<i>Barbarea vulgaris</i>	Bitter winter cress	2_Medium	Reduction
Brassicaceae	<i>Brassica napus</i>	Canola	2_Medium	Eradication
Brassicaceae	<i>Brassica rapa</i>	Field mustard	2_Medium	Eradication
Poaceae	<i>Bromus diandrus</i>	Ripgut brome	2_Medium	Eradication
Poaceae	<i>Bromus hordeaceus</i>	Soft chess	2_Medium	Eradication
Brassicaceae	<i>Capsella bursa-pastoris</i>	Shepherd's purse	2_Medium	Eradication

Family	Scientific Name	Common Name	Priority	Strategy
Caryophyllaceae	<i>Cerastium fontanum ssp. vulgare</i>	Common mouse-ear chickweed	2_Medium	Eradication
Amaranthaceae	<i>Chenopodium album</i>	Lamb's quarters	2_Medium	Reduction
Asteraceae	<i>Cichorium intybus</i>	Chicory	2_Medium	Eradication
Boraginaceae	<i>Cynoglossum officinale</i>	Beggar's lice	2_Medium	Eradication
Poaceae	<i>Dactylis glomerata</i>	Orchard grass	2_Medium	Reduction
Apiaceae	<i>Daucus carota</i>	Queen Anne's lace	2_Medium	Eradication
Brassicaceae	<i>Descurainia sophia</i>	Flixweed	2_Medium	Eradication
Poaceae	<i>Elymus repens</i>	Quackgrass	2_Medium	Eradication
Geraniaceae	<i>Erodium cicutarium</i>	African filaree	2_Medium	Eradication
Polygonaceae	<i>Fallopia convolvulus</i>	Climbing knotweed	2_Medium	Eradication
Asteraceae	<i>Filago pyramidata var. pyramidata</i>	Broadleaf cottonrose	2_Medium	Eradication
Poaceae	<i>Holcus lanatus</i>	Velvetgrass	2_Medium	Eradication
Asteraceae	<i>Hypochaeris radicata</i>	Hairy cat's-ear	2_Medium	Reduction
Asteraceae	<i>Lactuca canadensis</i>	Canadian wild lettuce	2_Medium	Reduction
Asteraceae	<i>Lactuca serriola</i>	Prickly lettuce	2_Medium	Reduction
Brassicaceae	<i>Lepidium campestre</i>	Field cress	2_Medium	Eradication
Brassicaceae	<i>Lepidium heterophyllum</i>	Purple-anther field pepperweed	2_Medium	Eradication
Brassicaceae	<i>Lepidium rudemale</i>	Narrow-leaved peppergrass	2_Medium	Eradication
Fabaceae	<i>Lotus corniculatus</i>	Common bird's-foot trefoil	2_Medium	Eradication
Asteraceae	<i>Matricaria discoidea</i>	Pineapple weed	2_Medium	Eradication
Fabaceae	<i>Melilotus albus</i>	White sweetclover	2_Medium	Reduction
Fabaceae	<i>Melilotus officinalis</i>	Yellow sweetclover	2_Medium	Reduction
Asteraceae	<i>Mycelis muralis</i>	Wall lettuce	2_Medium	Reduction
Onagraceae	<i>Oenothera laciniata</i>	Cutleaf evening primrose	2_Medium	Eradication
Poaceae	<i>Phleum pratense</i>	Timothy	2_Medium	Reduction
Plantaginaceae	<i>Plantago lanceolata</i>	Buckhorn plantain	2_Medium	Reduction
Plantaginaceae	<i>Plantago major</i>	Common plantain	2_Medium	Reduction
Poaceae	<i>Poa annua</i>	Annual bluegrass	2_Medium	Eradication
Polygonaceae	<i>Polygonum aviculare ssp. depressum</i>	Common knotweed	2_Medium	Reduction
Ranunculaceae	<i>Ranunculus repens</i>	Double flowered creeping buttercup	2_Medium	Eradication
Rosaceae	<i>Rosa canina</i>	Dog rose	2_Medium	Eradication
Polygonaceae	<i>Rumex crispus</i>	Curly dock	2_Medium	Reduction
Amaranthaceae	<i>Salsola tragus</i>	Prickly Russian thistle	2_Medium	Eradication
Asteraceae	<i>Senecio sylvaticus</i>	Wood groundsel	2_Medium	Containment
Asteraceae	<i>Senecio vulgaris</i>	Common groundsel	2_Medium	Eradication
Asteraceae	<i>Sonchus asper</i>	Prickly sow-thistle	2_Medium	Eradication

Family	Scientific Name	Common Name	Priority	Strategy
Asteraceae	<i>Tanacetum vulgare</i>	Common tansy	2_Medium	Eradication
Asteraceae	<i>Taraxacum officinale</i>	Common dandelion	2_Medium	Containment
Poaceae	<i>Thinopyrum intermedium</i>	Intermediate wheatgrass	2_Medium	Eradication
Fabaceae	<i>Trifolium aureum</i>	Golden clover	2_Medium	Eradication
Fabaceae	<i>Trifolium hybridum</i>	Alsike clover	2_Medium	Eradication
Fabaceae	<i>Trifolium pratense</i>	Red clover	2_Medium	Eradication
Fabaceae	<i>Trifolium repens</i>	Dutch clover	2_Medium	Containment
Asteraceae	<i>Tripleurospermum inodorum</i>	Scentless chamomile	2_Medium	Eradication
Poaceae	<i>Triticum aestivum</i>	Wheat	2_Medium	Eradication
Poaceae	<i>Agrostis capillaris</i>	Browntop	3_Low	Containment
Poaceae	<i>Agrostis gigantea</i>	Redtop	3_Low	Containment
Poaceae	<i>Alopecurus pratensis</i>	Meadow foxtail	3_Low	Containment
Poaceae	<i>Festuca rubra ssp. rubra</i>	Red fescue	3_Low	Containment
Poaceae	<i>Festuca trachyphylla</i>	Hard fescue	3_Low	Containment
Poaceae	<i>Lolium perenne</i>	Perennial ryegrass	3_Low	Containment
Juncaceae	<i>Luzula multiflora</i>	Common woodrush	3_Low	Containment
Polygonaceae	<i>Persicaria lapathifolia</i>	Pinkweed	3_Low	Containment
Poaceae	<i>Poa compressa</i>	Canada bluegrass	3_Low	Containment
Poaceae	<i>Poa pratensis ssp. irrigata</i>	Dryland Kentucky bluegrass	3_Low	Containment
Poaceae	<i>Poa pratensis ssp. pratensis</i>	Typical Kentucky bluegrass	3_Low	Containment
Rosaceae	<i>Potentilla norvegica</i>	Norwegian cinquefoil	3_Low	Containment
Poaceae	<i>Schedonorus arundinaceus</i>	Tall fescue	3_Low	Containment
Caryophyllaceae	<i>Spergularia rubra</i>	Red sand-spurrey	3_Low	Containment
Ranunculaceae	<i>Adonis aestivalis</i>	Pheasant eye	Watch	Eradicate if found
Boraginaceae	<i>Anchusa officinalis</i>	Common bugloss	Watch	Eradicate if found
Asteraceae	<i>Carduus acanthoides</i>	Plumeless thistle	Watch	Eradicate if found
Asteraceae	<i>Carduus nutans</i>	Musk thistle	Watch	Eradicate if found
Asteraceae	<i>Centaurea solstitialis</i>	St. Barnaby's thistle	Watch	Eradicate if found
Asteraceae	<i>Centaurea x gerstlaueri</i>	Meadow knapweed	Watch	Eradicate if found
Fabaceae	<i>Cytisus scoparius</i>	Scotch broom	Watch	Eradicated
Dipsacaceae	<i>Dipsacus fullonum</i>	Fuller's teasel	Watch	Eradicate if found
Euphorbiaceae	<i>Euphorbia esula</i>	Leafy spurge	Watch	Eradicate if found
Asteraceae	<i>Hieracium aurantiacum</i>	Devil's paintbrush	Watch	Eradicate if found
Asteraceae	<i>Hieracium caespitosum</i>	Yellow king-devil	Watch	Eradicate if found
Iridaceae	<i>Iris pseudacorus</i>	Yellow flag	Watch	Eradicate if found
Lamiaceae	<i>Lamium amplexicaule</i>	Common deadnettle	Watch	Eradicated
Brassicaceae	<i>Lepidium draba</i>	Heart-podded hoary cress	Watch	Eradicate if found
Brassicaceae	<i>Lepidium latifolium</i>	Broad-leaved peppergrass	Watch	Eradicate if found
Plantaginaceae	<i>Linaria dalmatica ssp. dalmatica</i>	Dalmatian toadflax	Watch	Eradicated

Family	Scientific Name	Common Name	Priority	Strategy
Plantaginaceae	<i>Linaria vulgaris</i>	Butter and eggs	Watch	Eradicate if found
Caryophyllaceae	<i>Lychnis coronaria</i> (<i>Silene coronaria</i>)	Mullein pink	Watch	Eradicate if found
Haloragaceae	<i>Myriophyllum spicatum</i>	Eurasian water milfoil	Watch	Eradicate if found
Poaceae	<i>Nardus stricta</i>	Matgrass	Watch	Eradicate if found
Menyanthaceae	<i>Nymphoides peltata</i>	Yellow floating heart	Watch	Eradicate if found
Rosaceae	<i>Rubus bifrons</i>	Himalayan blackberry	Watch	Eradicate if found
Lamiaceae	<i>Salvia aethiopis</i>	African sage	Watch	Eradicate if found
Asteraceae	<i>Silybum marianum</i>	Milk thistle	Watch	Eradicate if found
Poaceae	<i>Taeniatherum caput-medusae</i>	Medusahead	Watch	Eradicate if found
Poaceae	<i>Ventenata dubia</i>	North Africa grass	Watch	Eradicate if found

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

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