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Crater Lake National Park

Invasive Vegetation Management

2019 Annual Report

ON THIS PAGE
Invasive Vegetation Management Crew members investigate a native lily, *Lilium washingtonianum* ssp. *purpurascens*, during a survey at Crater Creek.
Photo by Vance McNees

ON THE COVER
Invasive Vegetation Management crew member looks out over the landscape within the Bybee Creek Fire burned area.
Photo by Sarah Hogan

Invasive Vegetation Management

2019 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.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

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Abstract

Work performed in 2019 by Crater Lake National Park's Invasive Vegetation Management program continued a steady 17-year effort to detect, contain, and reduce infestations of invasive plant species within the Park. The 2019 season marked the third year in which the Invasive Vegetation Management Plan was implemented, and the second full field season of Park-wide herbicide application. Using manual and chemical methods an estimated 180,240 invasive plants were treated in 2019. Two new-to-the-park invasive plant species were discovered this year: common hound's tongue (*Cynoglossum officinale*) was discovered near Park employee housing, and desert alyssum (*Alyssum desertorum*) was discovered at the Ponderosa Pine Picnic Area along Highway 62. While surveying new areas of the park five new large invasive plant infestations were discovered within the western half of the Park's backcountry areas.

Acknowledgments

The 2019 Invasive Vegetation Management seasonal crew at Crater Lake National Park was made possible through support provided by the U.S. Department of the Interior/National Park Service Burned Area Rehabilitation program. The Crater Lake National Park Revegetation crew helped with invasive plant survey and control efforts, namely Carson Ralls, Benjamin Wright, Melody Frederic, Scott Heisler, and Carrie Wyler. Invasive plant observations reported by other Crater Lake National Park employees were very helpful in preventing the spread of invasive plants. Sean Mohren assisted with database management.

Introduction

The 2019 field season marked the seventeenth year of recurring management of non-native, 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 non-native, 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, its abundant snowfall, and its relatively short growing season, CRLA has been better protected against invasion by non-native plant species than other NPS units. The IVM program at CRLA is tasked with protecting, maintaining, and improving the integrity of the Park's 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 the Park 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 the Park's visitors, employees, and partners on the Park's IVM program and involve them in prevention, control, and monitoring efforts.

6. *Collaboration*: communicate regularly with Park partners, including other federal, state, and county entities, and collaborate on invasive vegetation management and control.

The 2019 field season was productive and informative for the Invasive Vegetation Management program. The crew consisted of six members, though three of them on-boarded a month late due to delays in the hiring process. This was the third consecutive year implementing the 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.

The Park received 434 inches of snow over the 2018-2019 winter, which is approximately 89% of the average snowfall of 512 inches. On May 15, snowmelt progressed at lower elevations to allow invasive plant surveys to begin; from that date forward the 2019 season proceeded without

interruption. Park headquarters (~6,400' elevation) experienced snow-free conditions on June 28. Unlike the previous four years, there were no large-scale fires within the Park; air quality remained good for the entire season, and the Park received precipitation every month except July. There was continuing fuelbreak creation and pile burning by the CRLA Fire Management program along the western Highway 62 corridor. Other human-caused disturbances in the park this year included a large-scale hazard tree removal project in Mazama Campground and the beginning of Phase II of the Rim Drive Rehabilitation project. The disturbance resulting from Phase II implementation was in the form of geotechnical drilling rigs taking core samples of the road base. At least seven of those core samples were off pavement, which disturbed vegetation and soils.

Funding was received from the Department of the Interior/National Park Service Burned Area Rehabilitation (BAR) program to survey for and control invasive plants within the areas impacted by the 2016 Bybee Creek fire, the 2017 Blanket Creek and Spruce Lake fires, and the 2018 Timber Crater 6 fire. Areas targeted for invasive plant survey and control efforts included firelines, aerial fire retardant application zones, spike camps, and helispots.

Methods

Crater Lake has been divided into five IVM Zones (Backcountry, Developed Areas, Lakeshore, Roadside, and Staging Areas) and 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 the Park.

Non-native plant species are given a management priority of high, medium, low, or watch. All high priority species are actively targeted for control efforts; medium priority species are targeted as time and resources allow. Low priority species are usually not targeted for management, either because populations of those species are not aggressively spreading, or populations are beyond control. Watch species are those that have been documented within the Park, but have not been observed in >10 years, or species that are found outside of and proximal to the Park. If any watch species are found within the Park, they receive a management priority of high. These management priorities ay 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 non-native 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; this 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 weeds, 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. IVM crew gridding a burned area to survey for invasive plant species. Photo by Jen Hooke.

Once an invasive plant population is discovered, data are recorded including scientific name, UTM coordinates (Zone 10, NAD83 datum), total number of plants present, area that plants occupy (m^2), and treatment applied to the population. Data are input (Figure 2) into a Trimble Juno field computer using ArcPad software. Plants are either pulled from the soil intact using Hori-Hori 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 Park visitors, employees, and partners.

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

Figure 2. IVM crew member collecting data with a field computer. Photo by Hamilton Hasty.

Crew members carry a booklet containing images and descriptions of the known non-native 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 non-native plant species. 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 ArcPad or 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*, smooth brome –*Bromus inermis*, etc.; and extensive fibrous roots of St. John's wort –*Hypericum perforatum*) are most effectively treated with herbicide. Ten herbicides are approved for use in the Park, with five herbicides submitted and approved for use through the NPS Pesticide Use Permitting System (PUPS) in 2019 (Table 1). In addition to the same four herbicides used in previous years (Roundup ProMax, Roundup Custom, Milestone, and Transline), two herbicides were approved for use in 2019 as alternatives to glyphosate: Plateau and Polaris.

Table 1. Herbicides approved for use under the CRLA Invasive Vegetation Management Plan. Bold type indicates herbicides approved for use in 2019 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**	**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 (Figure 3), 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. Backpack sprayers are more traditionally used for herbicide application; however, CRLA contains very few invasive plant monocultures, thus hand sprayers generally have sufficient capacity. Hand sprayers have the advantage of being far more portable than backpack sprayers and allow the applicator to carry a normal backpack while working.

Figure 3. IVM staff mixing herbicide before a field day begins. Photo by Delacey Randall.

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 the Trimble Juno units, 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 (Figure 4). Inflorescences are removed and collected as they can attract pollinators and disseminate seeds before the herbicide is effective, 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 4. Canada thistle sprayed with herbicide. A temporary blue dye is added to herbicide mix for worker safety and efficacy. Photo by Jen Hooke.

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 15 – October 15, 2019. Approximately 180,240 invasive plants were controlled during the 2019 field season, including two non-native plant species that had not been previously recorded within CRLA: common hound's tongue (*Cynoglossum officinale*) and desert alyssum (*Alyssum desertorum*) (Figure 5). This brings the number of non-native plant species documented within CRLA to 91. Control efforts put forth by the 2019 IVM program are presented by general IVM zones.

Figure 5. New-to-CRLA invasive plant species encountered in 2019. Desert alyssum found near the Ponderosa Pine Picnic Area restroom (left). Photo by Elena Olsen. Common hound's tongue found near seasonal employee housing (right). Photo by Melody Frederic.

Backcountry Zone

The Park's backcountry zone includes areas away from roads, developed areas, staging areas, and the Crater Lake shoreline. A total of 81,628 invasive plants was treated in the Park's backcountry areas during the 2019 field season (Figure 12; Tables 2 and 3). The western half of the Park receives more precipitation from incoming Pacific storms than does the east side of the Park due to orographic effects; additionally, there is a history of grazing in some of the recent (1980s) additions to the Park's westernmost border. Due to these factors, the west side of the Park generally harbors more invasive plant infestations than the east side.

After four years of active fire seasons that were often restrictive of IVM work and survey activities, conditions during the 2019 field season were excellent and allowed for a more intensive focus on the Park's backcountry regions. Favorable conditions and more overnight trips (Figure 6) allowed the IVM crew to survey and treat new areas of the park along Copeland Creek, Bybee Creek, near Timber Crater, and thousands of

Figure 6. IVM crew hiking to a backcountry campsite while surveying the Spruce Lake fire. Photo by Elena Olsen.

Figure 7. Dense common mullein (*Verbascum thapsus*) population within the Blanket Creek fire. Photo by Vance McNees.

acres within the Spruce Lake and Blanket Creek fires. To that end, the IVM crew surveyed for and treated far more invasive species in the backcountry than any other year on record (Figure 7).

In 2019, the Red Blanket Canyon region of the Park harbored by far the largest invasive plant infestations (except for Rim Village). For reporting purposes, the Red Blanket Canyon and the Blanket Creek fire have been separated into two separate regions, although most of the Blanket Creek fire is embedded within the Red Blanket Canyon area. The Red Blanket Canyon encompasses the Park's lowest elevation (3,900') and contains one of the Park's most diverse floras. The area is characterized by very steep, rugged terrain that presents challenges for IVM work. Because of the expansive and difficult-to-access nature of this area of the Park the IVM crew spent portions of two weeks camping on site; this allowed the crew to survey significantly larger expanses of the region as well as find and treat many more invasive plants.

Approximately 36,057 invasive plants of nine species were treated between the two reporting regions with thousands more surveyed and recorded but not treated due to a lack of time. The invasive plant species that were most prevalent throughout the region as well as greatest in number were common mullein (*Verbascum thapsus*), bull thistle (*Cirsium vulgare*), woodland groundsel (*Senecio sylvaticus*), and wall lettuce (*Mycelis muralis*). For the second year in a row historical cheat grass (*Bromus tectorum*) populations were surveyed and no plants were found. A small historical population of St. John's wort in Red Blanket Canyon was surveyed but not treated due to the presence of St. John's wort beetle (*Chrysolina hyperici)*, a biological control agent (Figure 8). It is unknown if this beetle occurred naturally or was part of a biological control effort put forth by the USFS.

Figure 8. *Chrysolina hyperici* beetle feeding on St. John's wort in the Red Blanket Canyon. This individual appears to have been parasitized. Photo by Elena Olsen.

Surveys in two other burned areas within the Backcountry zone produced increased invasive plant species counts: the 2015 Crescent fire area within the National Creek Complex (NCC) and the 2016 Bybee Creek fire. In both areas, known and historically treated invasive plant populations expanded, perhaps due to established seed banks. Efforts were also made to survey more acreage within these burned areas, which yielded more invasive plant populations.

Other invasive plant populations in recently burned areas within the backcountry displayed encouraging reactions to treatment. The Castle fire invasive plant population numbers were reduced by 90%; the Upper Panhandle Burn Unit/Baboon fire by 80%; and the Spruce Lake fire (Figure 9) by 15% despite far more area being surveyed in 2019 over 2018.

Figure 9. IVM crew members grid a helispot within the Spruce Lake fire. Photo by Elena Olsen.

Invasive vegetation management within the Park's wetland and meadow systems continues to present its own challenges. For large portions of the year these areas contain too much standing water (e.g., Cottonwood Meadows, Spruce Lake) to apply herbicide and as water recedes throughout the season, native vegetation growth is often so dense as to make herbicide application challenging. This is especially true for white clover (*Trifolium repens*) and common dandelion, which thrive in wet areas, do not respond to or become more vigorous after manual treatments, and often set seed by the time water levels recede. Despite these difficulties, successive yearly treatments in Poison Meadows, Thousand Springs, and Spruce Lake have all yielded positive results for reducing and containing many invasive plant species populations.

Poison Meadows, while showing positive response to invasive plant treatment, is an especially vulnerable area. Its proximity to heavily infested meadows within the Rogue River Siskiyou National Forest combined with the proclivity of wildlife to browse and bed within the tall grass of the

meadow make for a constantly changing matrix of invasive plant populations. Efforts to expand surveys in 2019 led to the discovery and successful treatment of new populations of reed canarygrass (*Phalaris arundinacea* –Figure 10) and bull thistle.

Figure 10. Reed canarygrass at Poison Meadows before (left) and two months after (right) treatment with herbicide. Photos by Elena Olsen.

Treatment of invasive plant species at Cottonwood Meadows suffers from many of the same difficulties as Poison Meadows, but an added difficulty is its lower-elevation location within the Panhandle of the Park leading to a longer growing season. In 2019, surveys of this region were staggered throughout the season (June, July, and October), to treat multiple growth cycles. As a result, 3,105 invasive plants were treated in 2019 as compared to 2,552 in 2018 and even fewer in previous years

No invasive plant species were found in Sphagnum Bog. The riparian areas surveyed within the park in 2019 were Annie Creek, Lower Castle Creek, Crater Creek, Munson Creek, Pothole Creek, Sand Creek, Sun Creek, and the newly recorded region of Copeland Creek. The only non-native plant species found at Pothole and Munson Creeks was common dandelion. While the total invasive plant population numbers look large for Lower Bybee Creek, all 4,160 invasive plants encountered there were on ridgetops or meadows overlooking the riparian area and all of those were discovered in areas

that had never been surveyed for invasive plant species before. This highlights the importance of expanding invasive vegetation surveys within the Park.

Surveys in Annie Creek continue to detect robust invasive plant populations, though treatment does appear to be having an effect and overall treatment numbers are down. Populations in the areas that were treated in 2019 were down by nearly 40% over 2018. Bull thistle populations were decreased by 60% (228 treated in 2018, 89 in 2019) and the sheep sorrel populations found and treated in 2018 saw a slight decrease in size as well (from 449 in 2018 to 317 in 2019). Invasive plant populations located furthest upstream were not treated in 2019 due to lack of time.

The Crater Creek invasive plant infestation is bordered on one side by a U.S. Forest Service road and by a steep slope dropping down to Crater Creek on the other. This area has historically been infested with mostly bull thistle and Canada thistle, but in 2019 the IVM crew encountered a previously undetected population of wall lettuce (Figure 11). This population will need to be watched for expansion in the years to come. A small patch of common mouse-ear chickweed (*Cerastium fontanum* ssp. *vulgare*) was also found in this same clearing.

Figure 11. IVM crew members manually treating a dense patch of wall lettuce near Crater Creek. Photo by Elena Olsen.

Dense patches of common mouse-ear chickweed were recorded for the first time in lower Castle Creek in 2019 and will require early treatment in June 2020 before plants go to seed. The steep spring seeps that drain into lower Castle Creek host a diversity of native vegetation as well as several non-native plant species that are found few other places in the park in the Park: common mouse-ear chickweed, prickly sow thistle (*Sonchus asper*), and tall lettuce (*Lactuca canadensis*).

Table 2. Number of invasive plants treated in the Backcountry Zone from 2015—2019 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Backcountry Zone IVM Region	2019	2018	2017	2016	2015
Annie Creek	493	1,092	4,025	3,718	5,923
Blanket Creek Fire	15,200	3,892	*	*	*
Bybee Creek – Lower	4,160	*	*	*	44
Bybee Fire	2,267	626	699	*	*
Castle Creek – Lower	1,701	843	1,655	972	1,373
Castle Creek – North Fork	*	*	180	261	584
Castle Crest Wildflower Garden	0	*	12	*	1
Castle Fire	226	2,102	1,155	1,442	5,189
Copeland Creek	60	*	*	*	*
Cornerstone Burn Unit	0	*	0	*	*
Crater Creek	8,881	775	759	*	3,083
Desert Ridge Fire (NCC)	625	111	365	*	*
Munson Creek	430	*	*	*	*
National Creek	*	241	2,738	2,000	*
National Creek Complex	1,844	1,036	2,547	1,084	*
Panhandle – Interior	0	40	*	205	324
Panhandle – Cottonwood Meadow	3,105	2,552	2,255	469	1,591
PH3 Burn Unit	14	14	1	*	542
Poison Meadows	10,068	15,632	17,187	6,362	4,766
Pothole Creek	0	*	391	46	500
Pumice Complex	0	2	*	6	0
Red Blanket Canyon	20,857	960	2,809	8,965	16,448
Sand Creek	14	*	*	*	386
Scoria Fire	65	1	*	*	*
Spruce Lake	1,013	1,300	0	249	2,276
Spruce Lake Fire	2,581	3,008	*	*	*
Sun Creek	3,968	2,500	8,942	2,702	2,457
Thousand Springs (North & South)	2,876	6,076	3,800	3	*
Upper Panhandle Burn Unit/Baboon	1,120	5,880	1,519	1,116	16,467
Total	**81,628**	**48,683**	**51,024**	**29,600**	**61,411**

Table 3. Number of invasive plants treated in the Backcountry Zone from 2015—2019 by plant species. Asterisks (*) denote species that weren't encountered or treated in a particular year.

Plant Species	2019	2018	2017	2016	2015
Redtop *(Agrostis gigantea)*	72	*	*	*	*
Meadow foxtail *(Alopecurus pratensis)*	1	*	*	*	*
Smooth brome (*Bromus inermis*)	*	10	*	*	*
Cheat grass (*Bromus tectorum*)	*	*	*	105	161
Common mouse-ear chickweed (*Cerastium fontanum* ssp. *vulgare*)	219	*	*	*	*
Canada thistle (*Cirsium arvensis*)	1,113	1,454	4,091	2,942	757
Bull thistle (*Cirsium vulgare*)	13,334	8,396	7,554	13,166	34,899
Field bindweed (*Convolvulus arvensis*)	*	*	*	50	900
Tall orchardgrass (*Dactylis glomerata*)	15	*	*	1	*
Jerusalem oak (*Dysphania botrys*)	*	*	20	*	*
St. John's wort (*Hypericum perforatum*)	704	1,836	54	592	701
Hairy cat's ear (*Hypochaeris radicata*)	99	127	*	*	4
Dyer's woad (*Isatis tinctoria*)	*	*	74	*	*
Tall lettuce (*Lactuca canadensis*)	41	*	822	1	591
Prickly lettuce (*Lactuca serriola*)	1,228	671	229	401	1,124
Wall lettuce (*Mycelis muralis*)	8,156	399	*	*	*
Reed canarygrass (*Phalaris arundinacea*)	3,008	1,374	1,090	865	300
Timothy (*Phleum pratense*)	943	2,702	2,580	16	50
Annual bluegrass (*Poa annua*)	*	*	10	94	*
Bulbous bluegrass (*Poa bulbosa*)	*	*	*	*	55
Sheep sorrel (*Rumex acetosella*)	2,317	4,257	8,999	2,820	*
Curly dock (*Rumex crispus*)	14	*	*	*	72
Tansy ragwort (*Senecio jacobaea*)	3	421	10	9	*
Woodland groundsel (*Senecio sylvaticus*)	19,957	4,267	43	304	7,331
Common groundsel (*Senecio vulgaris*)	*	50	*	*	*
Prickly sow thistle (*Sonchus asper*)	318	185	1	*	39
Red sandspurry (*Spergularia rubra*)	*	200	*	*	*
Common dandelion (*Taraxacum officinale*)	13,131	12,274	17,565	3,323	3,779
Yellow salsify (*Tragopogon dubius*)	5,660	8,337	7,558	4,311	5,274
White clover (*Trifolium repens*)	325	85	235	112	*
Common mullein (*Verbascum thapsus*)	10,910	1,638	89	387	5,366

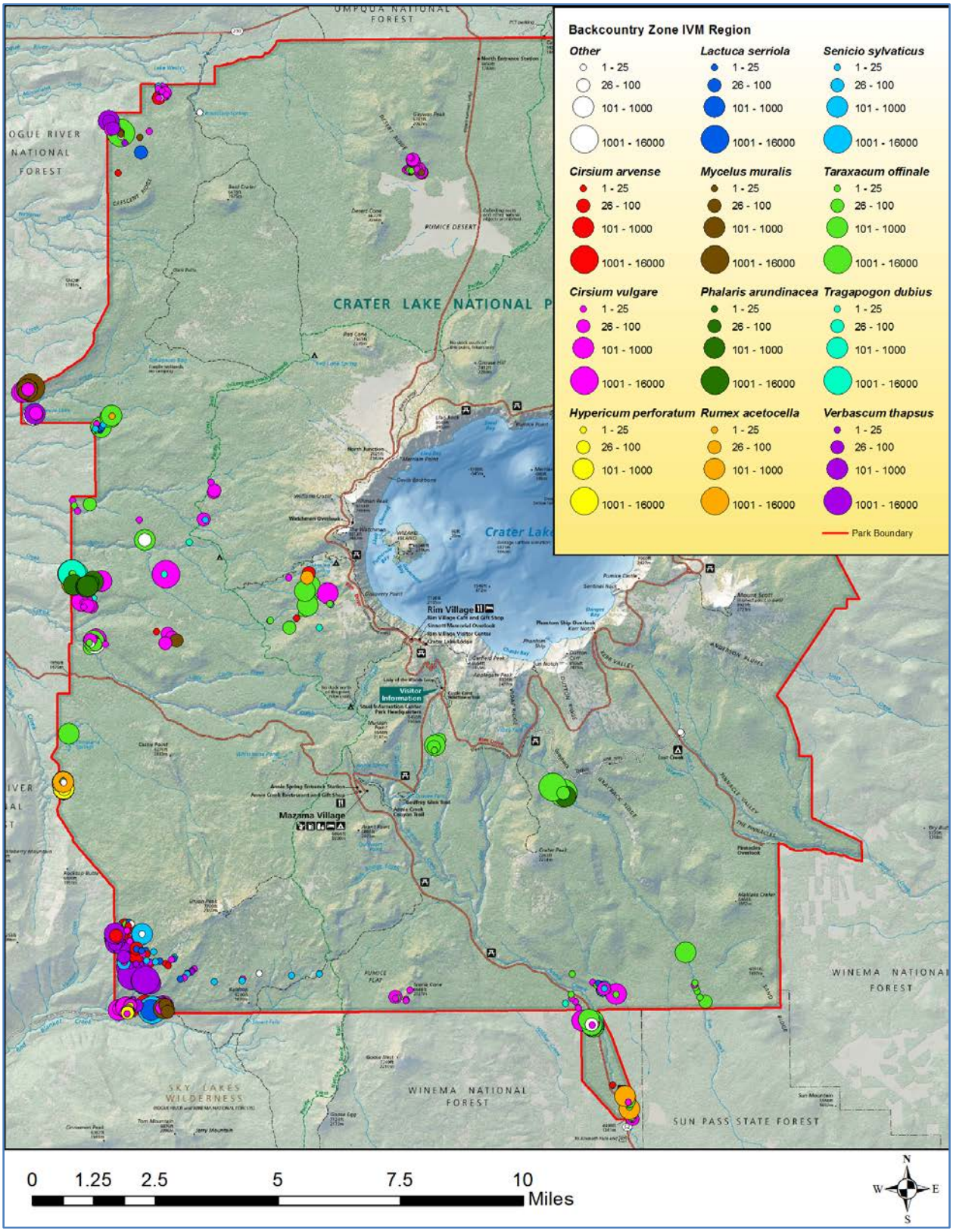

Figure 12. 2019 invasive plant populations in the Backcountry Zone. Map by Delacey Randall and Elena Olsen.

Developed Zone

The Park's developed areas are Rim Village, Park headquarters/housing, Mazama Dorms, Mazama Village and Cabins, Mazama Campground, the Park'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 2019, 83,902 individuals of 19 invasive plant species were controlled in the Park's developed areas (Figure 15). Comparisons with findings from the 2015 - 2018 field seasons are made in Tables 4 and 5. The large increase in total numbers treated in 2019 was primarily due to a concerted effort to reduce the increasing abundance of red sandspurry (*Spergularia rubra*) at Rim Village (Figure 13).

Most invasive plants in the Park's developed areas were found at Rim Village, with significant infestations at Park headquarters/housing and near Mazama Village as well. Across all developed areas, common knotweed (*Polygonum aviculare* ssp. *depressum*), sheep sorrel, and red sandspurry were the most commonly encountered invasive plant species. These species thrive in compacted soils and concrete crevices found throughout the developed zone.

Figure 13. Red sandspurry at Rim Village before (left) and after (right) treatment. Photos by Scott Heisler.

Yellow rocket (*Barbarea vulgaris*) continues to persist near the Crater Lake Lodge at Rim Village (311 individuals removed in 2019). A new-to-CRLA invasive plant species, common hound's tongue, was found near employee housing. Wild oats (*Avena* sp.) were found growing outdoors in pots at employee housing (Sleepy Hollow) and, unfortunately, dispersed seeds before they were discovered by the IVM crew. Since this genus contains aggressive weeds, the Sleepy Hollow housing area should be monitored in 2020 to ensure this plant does not establish.

Smooth brome continues to infest the landscaping islands and roadside near the Annie Spring entrance station and Mazama Village (see Roadside Zone for more detail). Individual plants of sweet clover (*Melilotus officinalis/albus*), rush skeletonweed (*Chondrilla juncea*), and chicory (*Cichorium intybus*) were treated at Mazama Village. Stinking pepperweed (*Lepidium ruderale*) was treated near the Rim Village Café and Gifts building and near the bathrooms in Mazama Campground. No

invasive plant species were found where extensive hazard tree removal was performed at Mazama Campground, however ground disturbance and tree damage from heavy equipment were ongoing beyond the end of the 2019 field season (Figure 14). The Annie Creek trail, which runs through Mazama Campground, has several invasive plant populations that were treated in 2019, most notably a large patch of common dandelion along the trail and several dense annual bluegrass (*Poa annua*) patches at the base of newly constructed footbridges.

Figure 14. Ground disturbance (left) and tree damage (right) from hazard tree removal at Mazama Campground. Photos by Elena Olsen.

There has been a substantial 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 2018 the sheep sorrel population consisted of approximately 7,263 plants, a significant portion of which were treated with herbicide. In 2019 that same population numbered approximately 1,659 plants, an 87% reduction in population size. It was also treated in its entirety in 2019.

Table 4. Number of invasive plants treated in the Developed Zone from 2015—2019 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Developed Zone IVM Region	2019	2018	2017	2016	2015
Headquarters/Housing	4,908	3,797	8,520	18,815	16,181
Lost Creek Campground	0	0	0	45	7
Mazama Campground	629	118	0	56	*
Mazama Dorms	43	3	1,048	4	*
Mazama Village	2,450	51	594	2,926	36
Rim Village	75,872	14,708	46,052	27,496	30,630
Total	**83,902**	**18,677**	**56,214**	**49,342**	**46,854**

Table 5. Number of invasive plants treated in the Developed Zone from 2015—2019 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2019	2018	2017	2016	2015
Meadow Foxtail (*Alopecurus pratensis*)	5	30	*	*	*
Yellow rocket (*Barbarea vulgaris*)	311	175	675	554	456
Smooth brome (*Bromus inermis*)	484	*	30	2,628	*
Common mouse-ear chickweed (*Cerastium fontanum* ssp. *vulgare)*	*	1	*	*	*
Rush skeletonweed (*Chondrilla juncea*)	1	*	*	*	*
Chicory (*Cichorium intybus*)	1	*	*	*	*
Canada thistle (*Cirsium arvensis*)	*	*	10	*	*
Bull thistle (*Cirsium vulgare*)	*	*	1	2	*
Common hound's tongue (*Cynoglossum officinale*)	1	*	*	*	*
Tall orchardgrass (*Dactylis glomerata*)	*	1	12	*	*
Broadleaf cottonrose (*Filago pyramidata* var. *pyramidata*)	0	500	1,025	135	500
St. John's wort (*Hypericum perforatum*)	1	9	11	125	16
Field pepperweed (*Lepidium campestre*)	*	*	*	*	15
Stinking pepperweed (*Lepidium ruderale*)	19	*	*	*	*
Birdsfoot trefoil (*Lotus corniculatus*)	*	*	1	*	2
Pineapple weed (*Matricaria discoidea*)	582	1,615	729	635	73
Yellow sweet clover (*Melilotus officinalis*)	1	*	1	*	*
English plantain (*Plantago lanceolata*)	3	1	3	*	*
Common plantain (*Plantago major*)	6	2	27	5	87
Annual bluegrass (*Poa annua*)	351	*	140	7	*
Bulbous bluegrass (*Poa bulbosa*)	*	*	1	*	*
Canada bluegrass (*Poa compressa*)	*	250	*	*	350
Common knotweed (*Polygonum aviculare* ssp. *depressum*)	6,180	305	1,019	*	*
Sheep sorrel (*Rumex acetosella*)	1,991	7,288	26,528	15,846	5,408
Curly dock (*Rumex crispus*)	*	*	25	*	6
Red sandspurry (*Spergularia rubra*)	73,236	8,103	24,717	25,046	38,542
Common dandelion (*Taraxacum officinale*)	600	294	713	2,857	834
Yellow salsify (*Tragopogon dubius*)	*	1	*	*	5
White clover (*Trifolium repens*)	128	102	545	1,333	533
Mullein (*Verbascum thapsus*)	1	*	1	2	2

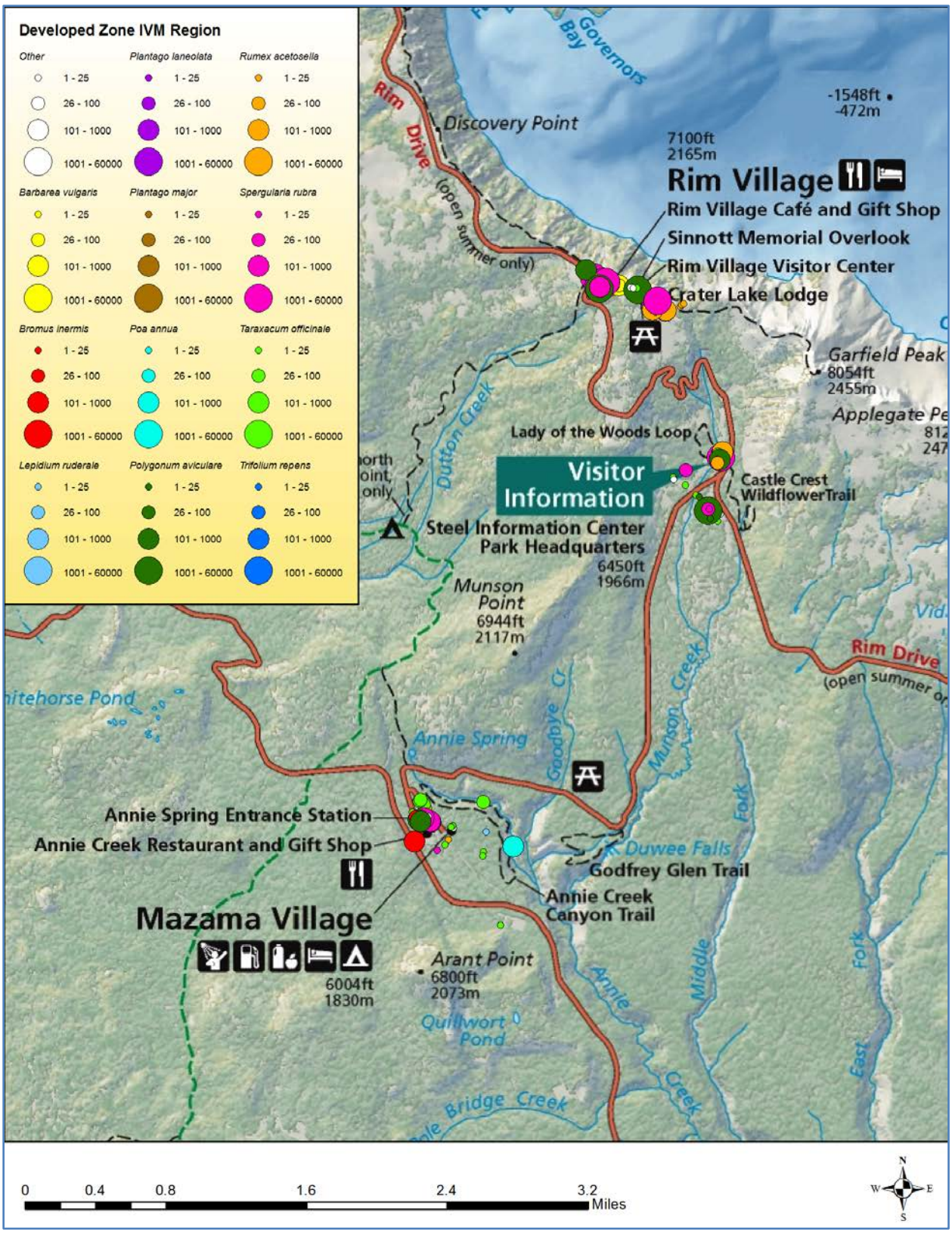

Figure 15. 2019 invasive plant populations in the Developed Zone. Map by Delacey Randall and Elena Olsen.

Lakeshore Zone

The shore of Crater Lake is the most difficult region of the park to survey for and treat invasive plant species. Access to most of the lakeshore is restricted by snowpack and the water level of the lake itself, and the limited ability of the Lake crew to shuttle the IVM crew from site to site makes sampling difficult. Timing is also paramount for the treatment of perennial or rhizomatous invasive plants to be effective. In 2019, the IVM crew spent three days surveying the lakeshore and Wizard Island. Surveys identified 198 individuals consisting of 11 invasive plant species in three different locations along the lake (Tables 6-7, Figure 17).

The Watchman Bench area of the "Discovery Point to Merriam Point" region had the largest diversity and number of invasive plant species along the lakeshore as well as some of the most persistent populations. Both the common mullein and Canada thistle populations along the bench have persevered through consistent treatment for over a decade. After a couple years of declining numbers, Canada thistle populations grew to 103 (comparable to 2015 or 2016 numbers) and 14 mullein plants were treated after three years without an occurrence.

Figure 16. The IVM crew gridding the Watchman Bench area along the lakeshore. Photo by Elena Olsen.

Three invasive plant species were encountered along the lakeshore this year for the first time: cheat grass, tansy ragwort (*Senecio jacobea*), and prickly sow thistle. While finding any new invasive plant species within the caldera is cause for alarm, finding cheat grass in this sensitive and extremely difficult-to-access area is by far the most alarming. Cheat grass can establish a monoculture very quickly by going through multiple life cycles within one growing season. Eight cheat grass individuals were found in one cluster below the Wineglass feature of the caldera. In 2016 a single cheat grass plant was manually treated at a pullout above Grotto Cove, suspiciously close to those

treated along the lakeshore in 2019. Due to safety concerns and Park closures of the caldera, areas below the caldera rim could not be surveyed. Instead, a thorough survey was performed from East Rim Drive to the caldera edge in the vicinity of the 2016 point to well past the 2019 occurrence; nothing was found.

Table 6. Number of invasive plants treated in the Lakeshore Zone from 2015-2019 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Lakeshore Zone IVM Region	**2019**	**2018**	**2017**	**2016**	**2015**
Cleetwood Cove to Skell Head	28	117	225	127	147
Skell Head to Eagle Point	*	0	*	0	*
Eagle Point to Discovery Point	*	0	0	338	*
Discovery Point to Merriam Point	156	469	15	203	173
Merriam Point to Cleetwood Cove	*	*	*	*	*
Wizard Island	14	0	13	5	122
Total	**198**	**586**	**253**	**606**	**442**

Table 7. Number of invasive plants treated in the Lakeshore Zone from 2015-2019 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	**2019**	**2018**	**2017**	**2016**	**2015**
Cheat grass (*Bromus tectorum*)	8	*	*	*	*
Canada thistle (*Cirsium arvensis*)	103	2	30	126	99
Bull thistle (*Cirsium vulgare*)	11	*	1	13	5
Jerusalem oak (*Dysphania botrys*)	*	*	2	*	*
St. John's wort (*Hypericum perforatum*)	*	408	210	31	110
Hairy cat's ear (*Hypochaeris radicata*)	15	*	*	9	9
Prickly lettuce (*Lactuca serriola*)	*	*	*	20	*
Wall lettuce (*Mycelis muralis*)	3	*	*	*	*
Kentucky bluegrass (*Poa pratensis*)	*	16	*	*	*
Sheep sorrel (*Rumex acetosella*)	*	144	*	300	*
Tansy ragwort (*Senecio jacobea*)	2	*	*	*	*
Woodland groundsel (*Senecio sylvaticus*)	21	*	*	*	122
Prickly sow thistle (*Sonchus asper*)	1	*	*	*	*
Common dandelion (*Taraxacum officinale*)	19	16	7	77	19
Yellow salsify (*Tragopogon dubius*)	1	*	3	30	*
Common mullein (*Verbascum thapsus*)	14	*	*	0	78

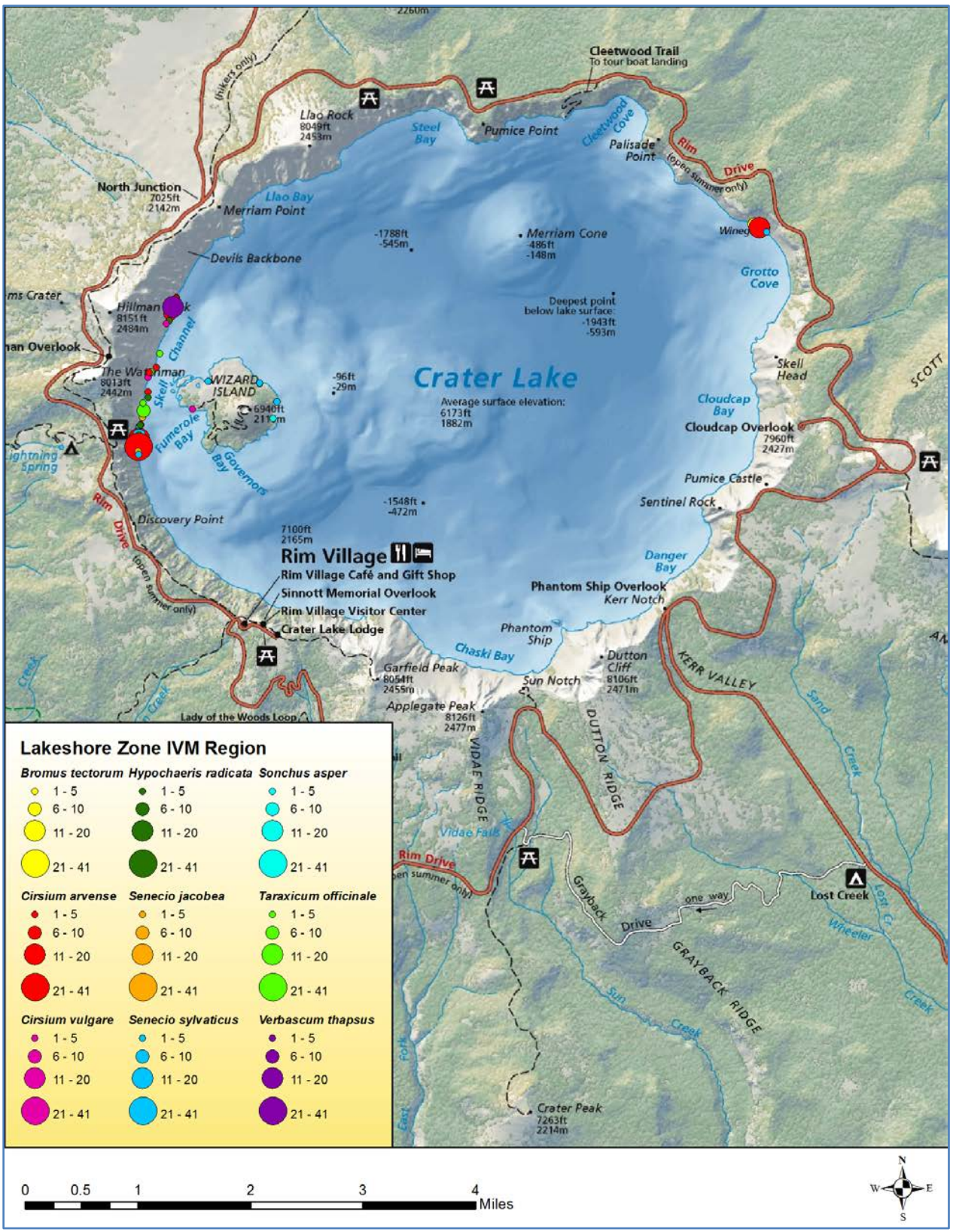

Figure 17. 2019 invasive plant populations in the Lakeshore Zone. Map by Delacey Randall and Elena Olsen.

Roadside Zone

Park roads include Highway 62, Munson Valley Road, West and East Rim Drives, Pinnacles Road, Grayback Road, North Entrance Road, and Highway 138. The greatest diversity and density of invasive plants in the park 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 2019, all roads within the Park were surveyed for invasive species. No invasive species were found or treated on Pinnacles Road in 2019, and Grayback Road (closed to public motor vehicle use) continues to remain free of invasive plant species. Thirty-one invasive plant species, totaling 14,408 individual plants, were treated along roadsides in 2019. Comparisons of roadside IVM regions surveyed and invasive plant species found during 2015 to 2019 field seasons are listed in Tables 8 and 9. Roadside locations of invasive plant species encountered in 2019 are displayed in Figure 19.

Figure 18. IVM crew members treating roadside weeds. Left: Removing smooth brome seed heads before chemical treatment (left). Surveying Munson Valley roadside (right). Photos by Benjamin Wright.

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 the Park to melt out in late spring. Highway 62, especially the section from the PCT trailhead to the south Park 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 the Park, has historically supported a diversity of invasive plant species (generally in small numbers), several of which have been found nowhere else in the Park. Infestations on Munson Valley Road are concentrated near developed areas (Mazama Village, pullouts, and Park headquarters) where there is high visitor traffic.

West and East Rim Drives continue to contain localized infestations of invasive plant species with portions of these roads found to be weed-free. Even after 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 presently barren and receptive to colonizing vegetation. North Entrance Road is typically sparsely colonized by invasive plants. Very few infestations have been found along this road in the past, with most being associated with the North Entrance Station infrastructure and the junction with Highway 138. Since 2015, the Pumice Desert overlook along the North Entrance Road has continued to support invasive plant infestations (purple anther field pepperweed –*Lepidium heterophyllum*; field bindweed – *Convolvulus arvensis*; and colonial bentgrass --- *Agrostis capillaris*) after it was used to stockpile gravel "chips" for a pavement preservation project in 2014.

The southernmost section of Highway 62 in the Panhandle region of the Park continues to sustain sizable populations of bulbous bluegrass (*Poa bulbosa*), with scattered small populations existing along Munson Valley Road and Highway 138 as well. Bulbous bluegrass reproduces through viviparous bulblets formed in the flowers. Plants die back in late spring, and over-winter as underground bulbs that put up shoots in early spring (or fall in favorable weather). 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. Shoots of bulbous bluegrass were also observed and hand-pulled in the Panhandle in fall 2019. Early control is important to prevent bulbous bluegrass from becoming a problematic weed in CRLA, as this species is a prolific weed in many western states (Scheinost et al. 2008). Bulbous bluegrass is also one of the few grasses that can establish within cheat grass stands (Stewart and Hull 1949).

Sheep sorrel, common dandelion and St. John's wort are early season targets for herbicide treatment along roadsides. 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 Park boundaries continue to be well below the peak of over 18,000 plants in 2006. In 2019, 592 individual 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 the Park.

Smooth brome remains persistent near Mazama Village along Highway 62 and Munson Valley Road. Six hundred eighty-seven individuals were treated in patches near the Annie Spring entrance station (in the landscaping beds and along both sides of Munson Valley Road), scattered along the rock face west of Highway 62/Munson Valley Road intersection, and behind the Highway 62 guardrails where the population extends downslope below the retaining wall. An effort should be made to target this population in late June 2020 when plants are flowering. The proximity of some populations to the entrance station and Annie Creek Restaurant restricts timing for herbicide treatment, and the section behind the guardrails is the densest section that can easily escape detection.

Several populations of infrequently encountered perennial grasses including orchard grass (*Dactylis glomerata*), meadow foxtail (*Alopecurus pratensis*), timothy (*Phleum pratensis)*, quackgrass (*Elymus repens*), and tall fescue (*Schenodorus arundinaceus*) were treated with glyphosate along Highway 62, Highway 138, and Munson Valley Road. Red fescue (*Festuca rubra*) and colonial bentgrass were treated along Highway 62 where they have recently established along the area disturbed by the Pacific Crest Well Pipeline project. Well-established and abundant populations of non-native grasses, including Kentucky bluegrass (*Poa pratensis)*, Canada bluegrass (*Poa compressa*), and colonial bentgrass, are only occasionally treated, and usually only when they threaten habitat for rare or sensitive plants or habitats. Cheat grass was not found at any historical roadside location along Highways 138 or 62, even after several targeted surveys in spring.

A newly discovered invasive plant species to the park, desert alyssum, was found at the Ponderosa Pine Picnic Area along the walkway to the restroom. This species is a short-statured annual in the mustard family, with yellow flowers and stellate hairs. Plants form dense stands in disturbed areas, flower in early spring, and typically disperse seeds by mid-late spring. Early detection of this small population (38 plants removed from a roughly $2m^2$ area) provides hope for eradication.

Spotted knapweed populations remain low after many years of regular treatment, with only a few patches of rosettes (21 plants total) found along Highway 138, down from a peak of 1,002 plants in 2004. Two localized populations of purple anther field pepperweed persist along Highway 138 and at the Pumice Desert Overlook. A population of Jerusalem oak (*Dysphania botrys*) along Munson Valley Road, believed to have been introduced to the Park through contaminated gravel used in a 2014 pavement preservation project, persists albeit at low numbers (47 found in September 2019). Plants in this population remain significantly small for the species (only 4-15 cm) and appear to have germinated in mid-late summer, likely triggered by summer rains (Cummings 1967). A drier summer in 2018 might explain why no plants were found during surveys that year.

Table 8. Number of invasive plants treated in the Roadside Zone from 2015—2019 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Roadside Zone IVM Region	2019	2018	2017	2016	2015
East Rim Drive	883	170	5,665	790	287
Highway 138	3,793	4,260	9,373	8,281	3,727
Munson Valley Road	1,966	3,547	4,649	3,692	25,897
North Entrance Road	149	0	160	126	337
Pinnacles Road	0	*	56	30	*
South Highway 62	5,517	11,723	24,212	12,441	12,847
West Highway 62	2,063	1,042	9,530	2,692	3,805
West Rim Drive	37	1	*	1,653	1,827
Total	**14,408**	**20,967**	**53,645**	**29,705**	**48,727**

Table 9. Number of invasive plants treated in the Roadside Zone from 2015—2019 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2019	2018	2017	2016	2015
Colonial bentgrass (*Agrostis capillaris*)	421	10	*	*	*
Redtop (*Agrostis gigantea*)	*	15	31	*	*
Meadow foxtail (*Alopecurus pratensis*)	1	83	*	*	8
Desert Alyssum (*Alyssum desertorum*)	38	*	*	*	*
Tall oatgrass *(Arrhenatherum elatius* var. *elatius*)	*	1	5	1	*
Yellow rocket (*Barbarea vulgaris*)	4	2	48	*	1
Field mustard (*Brassica rapa*)	*	1	*	*	2
Soft chess (*Bromus hordeaceus*)	*	*	*	1,659	129
Smooth brome (*Bromus inermis*)	687	731	11,235	2,186	2,537
Cheat grass (*Bromus tectorum*)	*	301	71	1,933	2,217
Shepherd's purse (*Capsella bursa-pastoris*)	*	*	*	*	1
Spotted knapweed (*Centaurea stoebe* ssp. *micranthos*)	21	12	33	58	517
Big chickweed (*Cerastium fontanum* ssp. *vulgare*)	*	*	*	*	47
Lambs quarters (*Chenopodium album*)	*	3	*	*	1,063
Rush skeletonweed (*Chondrilla juncea*)	1	2	5	3	3
Chicory (*Cichorium intybus*)	1	*	1	*	1
Canada thistle (*Cirsium arvensis*)	1	1	2	*	8
Bull thistle (*Cirsium vulgare*)	2	*	3	33	8
Field bindweed (*Convolvulus arvensis*)	3	9	15	20	17
Wild carrot (*Daucus carota*)	*	*	1	*	*
Tall orchardgrass (*Dactylis glomerata*)	10	*	*	30	20
Flixweed (*Descurainia sophia*)	*	*	*	1	*
Jerusalem oak (*Dysphania botrys*)	47	*	94	1,110	21,454
Quackgrass (*Elymus repens*)	422	*	*	425	186
African filaree (*Erodium cicutarium*)	*	*	*	*	1
Ivy bindweed (*Fallopia convolvulus*)	*	*	*	*	231
Red fescue (*Festuca rubra*)	50	*	*	*	*
Common velvetgrass (*Holcus lanatus*)	*	*	*	14	*
St. John's wort (*Hypericum perforatum*)	592	298	1,572	1,715	4,668
Hairy cat's ear (*Hypochaeris radicata*)	1	1	9	10	3
Dyer's woad (*Isatis tinctoria*)	*	*	31	*	*
Tall lettuce (*Lactuca canadensis*)	*	*	*	4	1
Prickly lettuce (*Lactuca serriola*)	3	*	*	*	35
Field pepperweed (*Lepidium campestre*)	*	16	*	*	28

Table 9 (Continued). Number of invasive plants treated in the Roadside Zone from 2015—2019 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2019	2018	2017	2016	2015
Purple anther field pepperweed (*Lepidium heterophyllum*)	237	197	410	24	12
Oxeye daisy (*Leucanthemum vulgare*)	*	7	10	60	79
Perennial ryegrass (*Lolium perenne*)	*	*	*	*	8
Birdsfoot trefoil (*Lotus corniculatus*)	*	*	*	*	1
Pineapple weed (*Matricaria discoidea*)	*	*	60	1	1
White sweet clover (*Melilotus albus*)	*	*	*	1	2
Reed canarygrass (*Phalaris arundinacea*)	*	12	*	*	20
Timothy (*Phleum pratense*)	9	15	102	*	78
English plantain (*Plantago lanceolata*)	32	3	*	5	981
Common plantain (*Plantago major*)	*	1	31	5	115
Annual bluegrass (*Poa annua*)	*	*	40	115	*
Bulbous bluegrass (*Poa bulbosa*)	2,616	6,423	9,251	2,340	3,900
Canada bluegrass (*Poa compressa*)	320	267	*	47	*
Kentucky bluegrass (*Poa pratensis*)	*	1,788	18	*	*
Common knotweed (*Polygonum aviculare* ssp. *depressum*)	3	*	296	30	1,168
Dog rose (*Rosa canina*)	*	*	*	1	*
Sheep sorrel (*Rumex acetosella*)	6,464	6,954	23,779	13,608	4,317
Russian thistle (*Salsola kali* ssp. *pontica*)	*	*	*	*	5
Tansy ragwort (*Senecio jacobaea*)	*	*	67	*	*
Woodland groundsel (*Senecio sylvaticus*)	*	5	*	1	1
Tall Fescue (*Schendonorus arundinaceus*)	38	*	*	*	*
Red sandspurry (*Spergularia rubra*)	10	28	*	1,799	1,404
Common tansy (*Tanacetum vulgare*)	*	1	*	*	*
Dandelion (*Taraxacum officinale*)	2,240	3,358	4,695	2,137	3,135
Pubescent wheatgrass (*Thinopyrum intermedium*)	*	75	*	*	36
Yellow salsify (*Tragopogon dubius*)	74	99	50	69	165
Scentless mayweed (*Tripleurospermum inodorum*)	*	*	*	1	1
Red clover (*Trifolium pratense*)	*	*	1	1	1
White clover (*Trifolium repens*)	54	30	1,642	188	6
Wheat (*Triticum aestivum*)	*	*	*	*	9
Mullein (*Verbascum thapsus*)	6	3	37	19	96

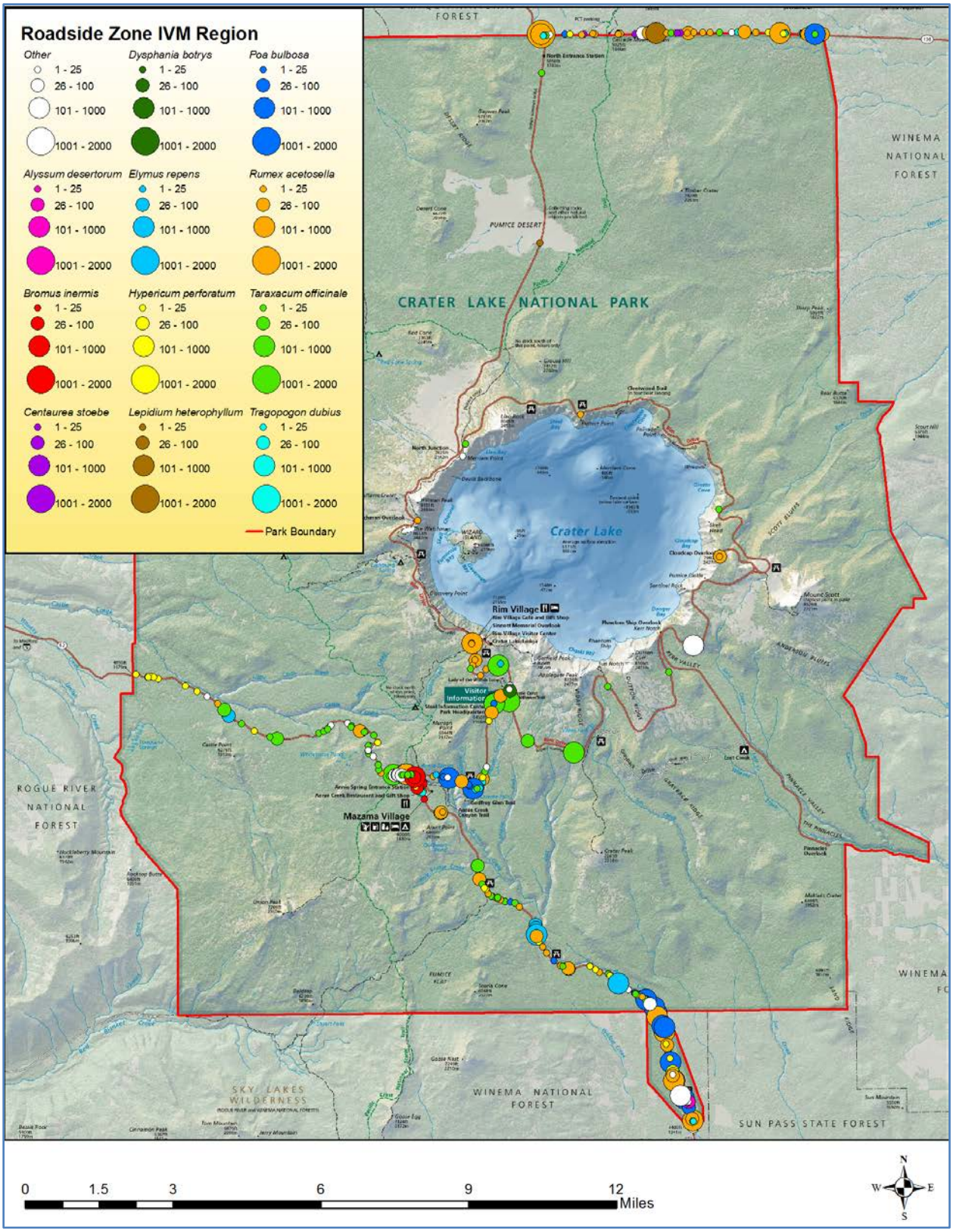

Figure 19. 2019 invasive plant populations in the Roadside Zone. Map by Delacey Randall and Elena Olsen.

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 the Park and move freely within the Park, it is vital that the IVM program keeps these areas as free of invasive plant species as possible. Staging area invasive plant locations encountered in 2019 are displayed in Figure 21. Comparisons with findings from the 2015 to 2019 field seasons are made in Tables 10 and 11.

In 2019, invasive plants were treated at three of the six staging areas: Pole Bridge Creek Quarry, South Yard, and Anderson Quarry. A total of 159 individuals were treated from four species: yellow rocket, yellow sweetclover, yellow salsify (*Tragopogon dubius*), and common mullein. Populations of red sandspurry still persist at the Ball Diamond, South Yard, and Pole Bridge Creek Quarry, but were not treated in 2019.

Yellow rocket continues to be the the most common invasive plant species encounted in these areas. In 2010, yellow rocket infestations at Anderson Quarry and Pole Bridge Creek Quarry were 1,010 and 435 individuals, respectively. In 2019, 7 yellow rocket plants were found at Anderson Quarry and 100 plants found at Pole Bridge Creek Quarry. Material from Anderson Quarry is actively being used by the Trails program as fill for Godfrey Glen Trail, Castle Crest Wildflower Garden, and Rim Trail maintenance. The section of the quarry infested with yellow rocket has been flagged off to prevent use by Trails, but these recently worked trails and nearby creeks should be monitored for invasive plant establishment. At Pole Bridge Creek Quarry, yellow rocket, including a tall mature plant, was found on top of a large boulder pile that was used elsewhere in the Park later in the summer (Figure 20). Care should be taken to survey areas where this material was applied as they may have been contaminated with weed seed.

Figure 20. Yellow rocket growing on a boulder pile at Pole Bridge Creek quarry. Photo by Melody Frederic.

Table 10. Number of invasive plants treated in the Staging Area Zone from 2015-2019 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Staging Area Zone IVM Region	2019	2018	2017	2016	2015
Anderson Quarry	7	47	1	73	25
Ball Diamond	*	0	1,420	*	*
Pole Bridge Creek Quarry	100	9	31	239	780
Roundtop Quarry	0	0	0	0	0
South Yard	52	5	74	16	1,255
Watchman Quarry	0	0	0	0	0
Total	**159**	**61**	**1,526**	**328**	**2,060**

Table 11. Number of invasive plants treated in the Staging Area Zone from 2015-2019 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2019	2018	2017	2016	2015
Burdock (*Arctium minor*)	*	*	*	*	1
Yellow rocket (*Barbarea vulgaris*)	107	9	11	300	700
Smooth brome (*Bromus inermis*)	*	*	5	*	*
Bull thistle (*Cirsium vulgare*)	*	1	4	*	*
Stinking pepperweed (*Lepidium ruderale*)	*	*	*	*	12
Yellow sweetclover (*Melilotus officinalis*)	45	*	*	*	*
Bulbous bluegrass (*Poa bulbosa*)	*	*	1	*	*
St. John's wort (*Hypericum perforatum*)	*	*	*	5	6
Red sandspurry (*Spergularia rubra*)	*	*	1,432	6	88
Common dandelion (*Taraxacum officinale*)	*	*	9	4	1
Yellow salsify (*Tragopogon dubius*)	6	2	31	*	*
Common mullein (*Verbascum thapsus*)	1	2	33	13	10

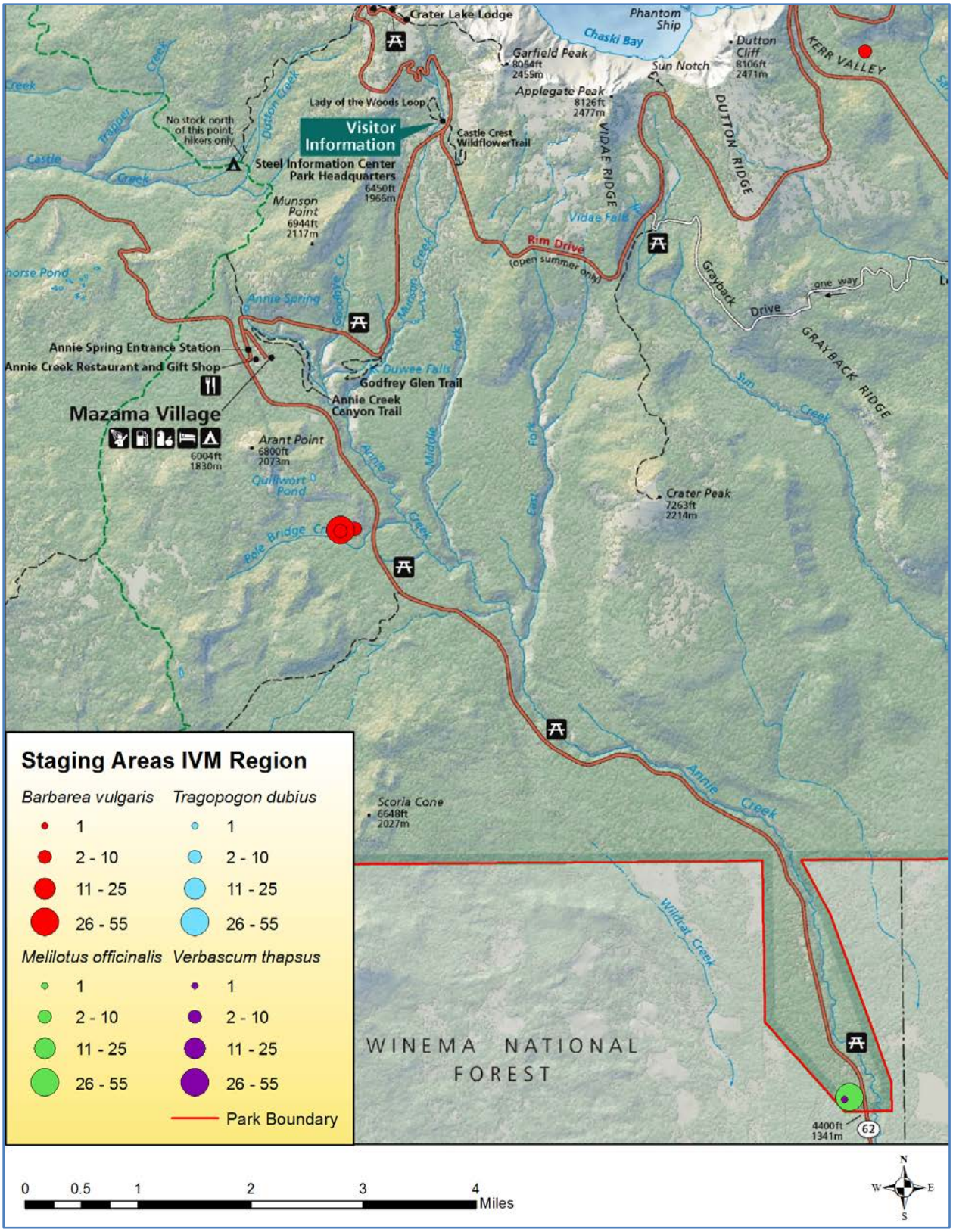

Figure 21. 2019 invasive plant populations in the Staging Areas Zone. Map by Delacey Randall and Elena Olsen.

Discussion

In 2019 there were several small-scale projects that will need IVM attention in 2020. The first is geotechnical drilling for Phase II of the Rim Drive Rehabilitation project. Another major project causing disturbance was an extensive hazard tree removal project in the Mazama Campground. Heavy equipment was brought in resulting in a large amount of ground disturbance in the area. Not only is the heavy equipment potentially a vector for invasive species introduction, the large amount of visitor traffic throughout the campground and newly exposed soil makes it prudent to survey this region multiple times in 2020.

On June, 30 dump truck loads of gravel were delivered to Pole Bridge Creek quarry from the Cherry Creek Pit. This material will be distributed at South Yard and the access road to the Pole Bridge Creek Quarry. These areas should be regularly monitored for new invasive plant introductions over the next few years. Finally, the CRLA Fire Management program continued fuelbreak creation and pile burning along the western Highway 62 corridor. It will be necessary to survey the affected area for several years to come.

As for large scale projects from the past several years, both the IVM and the Revegetation crews kept a close eye on those areas. For all the massive disturbance that was caused by Phase I of the Rim Drive Rehabilitation project, few invasive plants were found along the affected roadsides. While there may not be many observed invasive plant populations along West Rim Drive, it often takes several years for invasive plants to become established. Future IVM crews should continue to be diligent about surveying West Rim Drive.

Figure 22. Boot brush station installed at the PCT trailhead off West Highway 62. Photo by Delacey Randall.

Boot brush stations were installed during the 2019 field season at the PCT trailhead on West Highway 62 (Figure 22) and at the Garfield Peak trailhead near Rim Village. An additional boot brush station is planned for installation at the Cleetwood Cove trailhead in 2020. These need weekly maintenance throughout the season to clean out soil and debris. The boot brush stations share an important message with Park visitors and enlist their assistance with preventing the spread of non-native plant species into and within the Park.

Backcountry surveys were widely expanded in 2019 resulting in numerous new invasive plant populations being discovered and known infestations getting larger. New infestations were discovered in a meadow north of Bybee Creek, on a hilltop south of Bybee Creek, downstream from the sewage ponds along Munson Creek, and along Copeland Creek. East to west surveys of the Blanket Creek Fire from the Stuart Falls Trail to the Park boundary discovered that the

already extensive invasive plant populations are much larger than previously known. The entire eastern half of the Blanket Creek Fire will need to be a high priority in 2020.

Additional recommendations for IVM work in 2020 include:

- Future Timber Crater 6 BAR surveys should focus on areas where the fire overlaps the Cornerstone burn scar as this area is largely denuded of vegetation and close to invasive plant infestations along Highway 138.
- Expend extra effort surveying the Grotto Cove area along the lakeshore to search for any possible cheat grass 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.
- Frequent and thorough surveys of all meadows in the Poison Meadows area are necessary. This area has large, established, and diverse populations of invasive plant species. An effort should be made to focus on treating expanding reed canarygrass populations.
- National Creek and the upper stretches of Annie Creek were not surveyed in 2019. It will be very important to expend extra effort in these areas, especially the known Canada thistle infestation along National Creek.
- 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.
- Ensure unknown plant data forms are complete and that crew members are given the time and encouragement to properly key specimens.
- Perform bi-weekly data quality control checks when the data is uploaded and herbicide record forms are updated.
- The IVM crew needs to continue to use boot brushes daily and perform daily checks of crew gear for soil and invasive plant seeds.
- Plan backcountry camping trips early in the season to ensure administrative staff can establish travel-related accounts in time. Camping in the Lower Red Blanket Canyon was very successful in 2019.
- Manually treat desert alyssum at the Ponderosa Pine Picnic Area in early May and collect a flowering voucher specimen.
- Monitor South Yard and Pole Bridge Creek Quarry for invasive plant species that may have been introduced with the Cherry Creek Pit gravel.
- Monitor Godfrey Glen trail where material from Anderson Quarry was used due to potential contamination with yellow rocket.

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