National Park Service
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Crater Lake National Park

Invasive Vegetation Management

2020 Annual Report

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An Invasive Vegetation Management crew member surveys for invasive plants at Poison Meadows.
Photo by Shane Palmer.

ON THE COVER
The Invasive Vegetation Management crew surveys for invasive plants within the area burned by the 2017 Blanket Creek fire.
Photo by Shane Palmer.

Invasive Vegetation Management

2020 Annual Report

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Crater Lake National Park
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April 2021

U.S. Department of the Interior
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Crater Lake National Park
Crater Lake, Oregon

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.

This report is available in digital format from the Crater Lake National Park website at:

https://irma.nps.gov/DataStore/Reference/Profile/2285253

Please cite this publication as:

Hasty, H.L, J.S. Hooke, and S.E. Heisler. 2021. Invasive Vegetation Management: 2020 Annual Report. Crater Lake National Park, Crater Lake, Oregon.

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Acknowledgments

The 2020 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 National Park Service Natural Resource Cyclic Maintenance program, and the National Park Service Alternative Fuels Management project. Delacey Randall, Carrie Wyler, Shaina Nicassio, Eleanor Roeder, and Shane Palmer assisted with field work and data entry. 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. Allison Snyder of the Klamath Inventory and Monitoring Network assisted with the migration of field data collection to ArcGIS Collector.

Introduction

The 2020 field season marked the eighteenth 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, 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 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 2020 field season was impacted by the Covid-19 pandemic on many levels. The planned number of IVM crew members could not be hired due to reductions in the number of Park employees who could be accommodated in Park housing. Workplace Standard Operating Procedures (SOPs) designed to reduce and mitigate the risks of contracting and spreading the Covid-19 virus included canceling all backcountry camping trips; turning seasonal housing units into home offices; requiring each employee to travel in their own vehicle; and maintaining social distancing while working, training, and communicating. Despite these many challenges the 2020 field season was productive

and informative for the Invasive Vegetation Management program. The crew consisted of five members, though three of them split their time with the CRLA Revegetation crew. This was the fourth 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 360 inches of snow over the 2019—2020 winter, which is approximately 75% of the average snowfall of 483 inches. Field work commenced on May 27 and ended on October 27. Park headquarters (~6,400' elevation) experienced snow-free conditions on June 20. This year there were several large fires surrounding the Park that contributed to hazardous air quality for several weeks during the months of August and September. Large Park projects causing ground disturbance were limited to continuing fuelbreak and defensible space creation by the CRLA Fire Management program near Park headquarters, Mazama Village, and along the southern Highway 62 corridor.

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 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. Additional funding was received to survey for and treat invasive plants around the Park's facilities (e.g., buildings, roads, trails) from the NPS Natural Resource Cyclic Maintenance program. Support was also received from the NPS Alternative Fuels Management project and intended to fund interns to assist with invasive plant survey and control work in association with fuels mitigation work. However, no housing was available to support the interns due to the Covid-19 pandemic, so it is hoped the interns can assist with IVM work in future field seasons.

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

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 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.

Figure 1. The IVM crew surveying for invasive plants by gridding a recently burned area. Photo by Shane Palmer.

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.

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 an iPad equipped with ArcGIS Collector 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 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.

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 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 2020 (Table 1).

Table 1. Herbicides approved for use under the CRLA Invasive Vegetation Management Plan. Bold type indicates herbicides approved for use in 2020 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

Figure 2. Left: An IVM crew member collects data using an iPad with ArcGIS Collector. Photo by Shane Palmer. Right: IVM staff demonstrating how to mix herbicide. Photo by Jen Hooke.

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 2), 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. 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 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 3). 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 3. An IVM crew member treating Canada thistle with herbicide (left); closeup of treated plant (right). Photos 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 27 – October 27, 2020. Approximately 112,328 invasive plants were controlled during the 2020 field season, including one non-native plant species that had not been previously recorded within CRLA: sulfur cinquefoil *(Potentilla recta)*. This brings the number of non-native plant species documented within CRLA to 91; however, 28 of those species have not been encountered within the Park in recent years. Control efforts put forth by the 2020 IVM program are presented by general IVM zones.

Backcountry Zone

The Park's backcountry zone includes areas away from roads, developed areas, staging areas, and the Crater Lake shoreline. A total of 58,909 invasive plants were treated in the Park's backcountry areas during the 2020 field season (Figure 7; 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.

Due to new SOPs and restrictions brought on by the Covid-19 pandemic, as well as an active fire season that caused hazardous air quality conditions, the IVM crew did not survey as much area as planned during the 2020 field season. The crew mainly focused on treating known invasive plant populations; the only new infestations were located within the Spruce Lake fire. In previous years backcountry camping and backpacking were utilized to allow more remote area to be surveyed and treated. Covid-19 safety precautions did not allow for backcountry travel in 2020.

In 2020, the Blanket Creek fire (Figure 4) harbored one of the largest invasive plant infestations in the Park, with the exceptions being Rim Village and the Crater Creek regions. 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 lower portion of this area was inaccessible during the 2020 field season due to downed trees blocking the access road for most of the field season. Several days were spent surveying and treating infestations in the accessible (upper) portion of the Blanket Creek fire in order to cover large expanses of the region. Approximately 13,936 invasive plants consisting of eight different plant species were treated in that region alone. The invasive plant species that were most prevalent throughout the region as well as found in greatest in number were cowboy toilet paper (*Verbascum thapsus*), Canada thistle, bull thistle (*Cirsium vulgare*), and wood groundsel (*Senecio*

sylvaticus). A population of cheatgrass *(Bromus tectorum)* was also discovered in the region; there have been cheatgrass infestations previously found in the Red Blanket Canyon, but not for several years.

Figure 4. A cowboy toilet paper infestation within areas burned by the 2017 Blanket Creek fire. Photos by Jen Hooke.

Surveys in two other burned areas within the Backcountry zone produced decreased 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 yielded far fewer numbers than previous years. This is perhaps a response to continual treatment throughout the years or a result of an inability to survey as much acreage in 2020 due to restrictions brought on by the Covid-19 pandemic.

Other invasive plant populations in recently burned areas within the backcountry displayed encouraging responses to treatment. The Castle fire invasive plant population numbers were reduced by 45% and the Upper Panhandle Burn Unit/Baboon fire by 90%; however, the Spruce Lake fire increased by more than 25% despite less area being surveyed in 2020 over 2019.

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 (Figure 5), 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*) and bull thistle. However, new populations of sheep sorrel (*Rumex acetosella*) and St. John's wort discovered in 2020 were left untreated due to lack of time and resources.

Figure 5. Crew members inspect a newly discovered patch of sheep sorrel found in Poison Meadows. Photo by Shane Palmer.

Treatment of invasive plant species at Cottonwood Meadows suffers from many of the same difficulties as Poison Meadows, but its lower-elevation location within the Panhandle of the Park leads to an even longer growing season. In 2020, surveys of this region mainly took place in June with an additional survey taking place in September. Approximately 2,015 invasive plants were treated in 2020, which is similar to previous years' efforts.

The riparian areas surveyed within the park in 2020 were Annie Creek, Bybee Creek, Lower Castle Creek, Crater Creek (Figure 6), and National Creek. A total of 188 invasive plants were encountered in the Lower Bybee Creek region, but all of those plants were found on ridgetops or meadows

overlooking the riparian area. The population was first discovered in 2019 and appears to have responded extremely well to treatment compared to a population size of almost 4,000 last year.

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 2020 were down by over 45% over 2019. Although bull thistle populations increased (89 plants treated in 2019 vs. 242 plants in 2020) there were no sheep sorrel populations found in historical spots in the Annie Creek region.

Figure 6. IVM crew members treating invasive plants near Crater Creek with a backpack sprayer. Photo by Shaina Nicassio.

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 (*Cerastium fontanum* ssp. *vulgare* -- though none was found in 2020), prickly sow thistle (*Sonchus asper*), and tall lettuce (*Lactuca canadensis*).

Table 2. Number of invasive plants treated in the Backcountry Zone from 2016—2020 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Backcountry Zone IVM Region	2020	2019	2018	2017	2016
Annie Creek	279	493	1,092	4,025	3,718
Blanket Creek Fire	13,936	15,200	3,892	*	*
Bybee Creek – Lower	188	4,160	*	*	*
Bybee Fire	704	2,267	626	699	*
Castle Creek – Lower	744	1,701	843	1,655	972
Castle Creek – North Fork	0	*	*	180	261
Castle Crest Wildflower Garden	0	0	*	12	*
Castle Fire	124	226	2,102	1,155	1,442
Copeland Creek	*	60	*	*	*
Cornerstone Burn Unit	0	0	*	0	*
Crater Creek	30,642	8,881	775	759	*
Desert Ridge Fire (NCC)	110	625	111	365	*
Munson Creek	*	430	*	*	*
National Creek	279	*	241	2,738	2,000
National Creek Complex	432	1,844	1,036	2,547	1,084
Panhandle – Interior	0	0	40	*	205
Panhandle – Cottonwood Meadow	2,015	3,105	2,552	2,255	469
PH3 Burn Unit	*	14	14	1	*
Poison Meadows	4,834	10,068	15,632	17,187	6,362
Pothole Creek	0	0	*	391	46
Pumice Complex	3	0	2	*	6
Red Blanket Canyon	*	20,857	960	2,809	8,965
Sand Creek	0	14	*	*	*
Scoria Fire	39	65	1	*	*
Spruce Lake	659	1,013	1,300	0	249
Spruce Lake Fire	3,274	2,581	3,008	*	*
Sun Creek	0	3,968	2,500	8,942	2,702
Thousand Springs (North & South)	552	2,876	6,076	3,800	3
Upper Panhandle Burn Unit/Baboon	95	1,120	5,880	1,519	1,116
Total	**58,909**	**81,628**	**48,683**	**51,024**	**29,600**

Table 3. Number of invasive plants treated in the Backcountry Zone from 2016—2020 by plant species. Asterisks (*) denote species that weren't encountered or treated in a particular year.

Plant Species	2020	2019	2018	2017	2016
Redtop *(Agrostis gigantea)*	*	72	*	*	*
Meadow foxtail *(Alopecurus pratensis)*	*	1	*	*	*
Yellow rocket *(Barbarea vulgaris)*	238	*	*	*	*
Smooth brome (*Bromus inermis*)	*	*	10	*	*
Cheatgrass (*Bromus tectorum*)	12	*	*	*	105
Common mouse-ear chickweed (*Cerastium fontanum* ssp. *vulgare*)	*	219	*	*	*
Canada thistle (*Cirsium arvensis*)	635	1,113	1,454	4,091	2,942
Bull thistle (*Cirsium vulgare*)	3,440	13,334	8,396	7,554	13,166
Field bindweed (*Convolvulus arvensis*)	*	*	*	*	50
Tall orchardgrass (*Dactylis glomerata*)	*	15	*	*	1
Jerusalem oak (*Dysphania botrys*)	*	*	*	20	*
St. John's wort (*Hypericum perforatum*)	136	704	1,836	54	592
Hairy cat's ear (*Hypochaeris radicata*)	4	99	127	*	*
Dyer's woad (*Isatis tinctoria*)	*	*	*	74	*
Tall lettuce (*Lactuca canadensis*)	16	41	*	822	1
Prickly lettuce (*Lactuca serriola*)	169	1,228	671	229	401
Wall lettuce (*Mycelis muralis*)	30,040	8,156	399	*	*
Reed canarygrass (*Phalaris arundinacea*)	*	3,008	1,374	1,090	865
Timothy (*Phleum pratense*)	200	943	2,702	2,580	16
Annual bluegrass (*Poa annua*)	*	*	*	10	94
Bulbous bluegrass (*Poa bulbosa*)	*	*	*	*	*
Sheep sorrel (*Rumex acetosella*)	838	2,317	4,257	8,999	2,820
Curly dock (*Rumex crispus*)	*	14	*	*	*
Tansy ragwort (*Senecio jacobaea*)	*	3	421	10	9
Woodland groundsel (*Senecio sylvaticus*)	5,611	19,957	4,267	43	304
Common groundsel (*Senecio vulgaris*)	*	*	50	*	*
Prickly sow thistle (*Sonchus asper*)	104	318	185	1	*
Red sandspurry (*Spergularia rubra*)	*	*	200	*	*
Common dandelion (*Taraxacum officinale*)	2,468	13,131	12,274	17,565	3,323
Yellow salsify (*Tragopogon dubius*)	3,615	5,660	8,337	7,558	4,311
White clover (*Trifolium repens*)	1,099	325	85	235	112
Cowboy toilet paper (*Verbascum thapsus*)	10,484	10,910	1,638	89	387

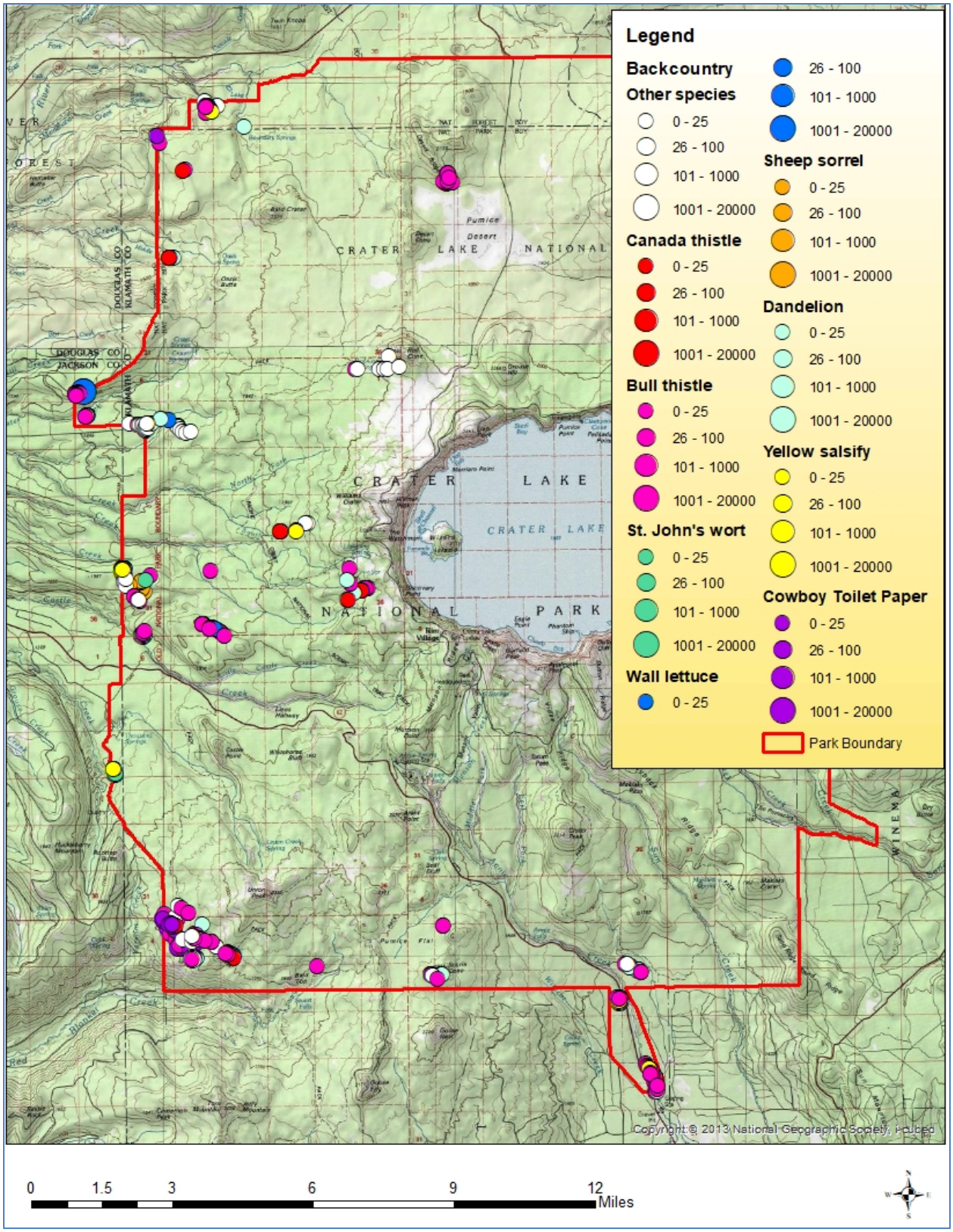

Figure 7. 2020 invasive plant populations in the Backcountry Zone. Map by Scott Heisler.

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 2020, 41,095 individuals of 15 different invasive plant species were controlled in the Park's developed areas (Figure 10). Comparisons with findings from the 2016 - 2019 field seasons are made in Tables 4 and 5. The decrease in total numbers treated in 2020 was primarily due to a large population of red sand-spurrey *(Spergularia rubra)* being treated in 2019 and returning in far fewer numbers in 2020 (Figure 8).

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 sand-spurrey were the most commonly encountered invasive plant species. These species thrive in compacted soils and concrete crevices found throughout the developed zone.

Figure 8. Red sand-spurrey (low light green plant) 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 (3,213 individuals removed in 2020). Common hound's tongue, a species new to the Park in 2019, was not found in 2020. Wild oats (*Avena* sp.) were found growing outdoors in pots at employee housing (Sleepy Hollow) in 2019; however, no individuals were found during the 2020 season.

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). No invasive plant species were found growing where extensive hazard tree removal was performed at Mazama Campground in 2019. Extensive fuel breaks were created by the CRLA Fire Management program in 2020 near Park Headquarters (Figure 9), Mazama Village and the southern corridor of Highway 62. These areas

were surveyed and treated in 2020 and will continue to receive follow-up work for two additional years.

Figure 9. Invasive Vegetation Management crew members surveying for invasive plants after fuel break creation activities near Park headquarters. Photo by Carrie Wyler.

There has been a continuing 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 2019 the sheep sorrel population consisted of approximately 1,659 plants, all of which were treated with herbicide. In 2020 that same population numbered approximately 1,300 plants, a 20% reduction in population size. It was also treated in its entirety in 2020.

Table 4. Number of invasive plants treated in the Developed Zone from 2016—2020 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Developed Zone IVM Region	2020	2019	2018	2017	2016
Headquarters/Housing	7,728	4,908	3,797	8,520	18,815
Lost Creek Campground	0	0	0	0	45
Mazama Campground	0	629	118	0	56
Mazama Dorms	174	43	3	1,048	4
Mazama Village	167	2,450	51	594	2,926
Rim Village	33,026	75,872	14,708	46,052	27,496
Total	**41,095**	**83,902**	**18,677**	**56,214**	**49,342**

Table 5. Number of invasive plants treated in the Developed Zone from 2016—2020 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2020	2019	2018	2017	2016
Redtop *(Agrostis gigantea)*	282	*	*	*	*
Meadow Foxtail (*Alopecurus pratensis*)	*	5	30	*	*
Yellow rocket (*Barbarea vulgaris*)	213	311	175	675	554
Smooth brome (*Bromus inermis*)	30	484	*	30	2,628
Cheatgrass *(Bromus tectorum)*	1				
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
St. John's wort (*Hypericum perforatum*)	11	1	9	11	125
Field pepperweed (*Lepidium campestre*)	*	*	*	*	*
Stinking pepperweed (*Lepidium ruderale*)	*	19	*	*	*
Birdsfoot trefoil (*Lotus corniculatus*)	*	*	*	1	*
Pineapple weed (*Matricaria discoidea*)	7	582	1,615	729	635
Yellow sweet clover (*Melilotus officinalis*)	*	1	*	1	*
English plantain (*Plantago lanceolata*)	2	3	1	3	*
Common plantain (*Plantago major*)	*	6	2	27	5
Annual bluegrass (*Poa annua*)	113	351	*	140	7
Bulbous bluegrass (*Poa bulbosa*)	161	*	*	1	*
Canada bluegrass (*Poa compressa*)	*	*	250	*	*
Common knotweed (*Polygonum aviculare* ssp. *depressum*)	2,598	6,180	305	1,019	*
Sheep sorrel (*Rumex acetosella*)	3,427	1,991	7,288	26,528	15,846
Curly dock (*Rumex crispus*)	*	*	*	25	*
Red sandspurry (*Spergularia rubra*)	34,126	73,236	8,103	24,717	25,046
Common dandelion (*Taraxacum officinale*)	109	600	294	713	2,857
Yellow salsify (*Tragopogon dubius*)	*	*	1	*	*
Dutch clover (*Trifolium repens*)	1	*	*	*	*

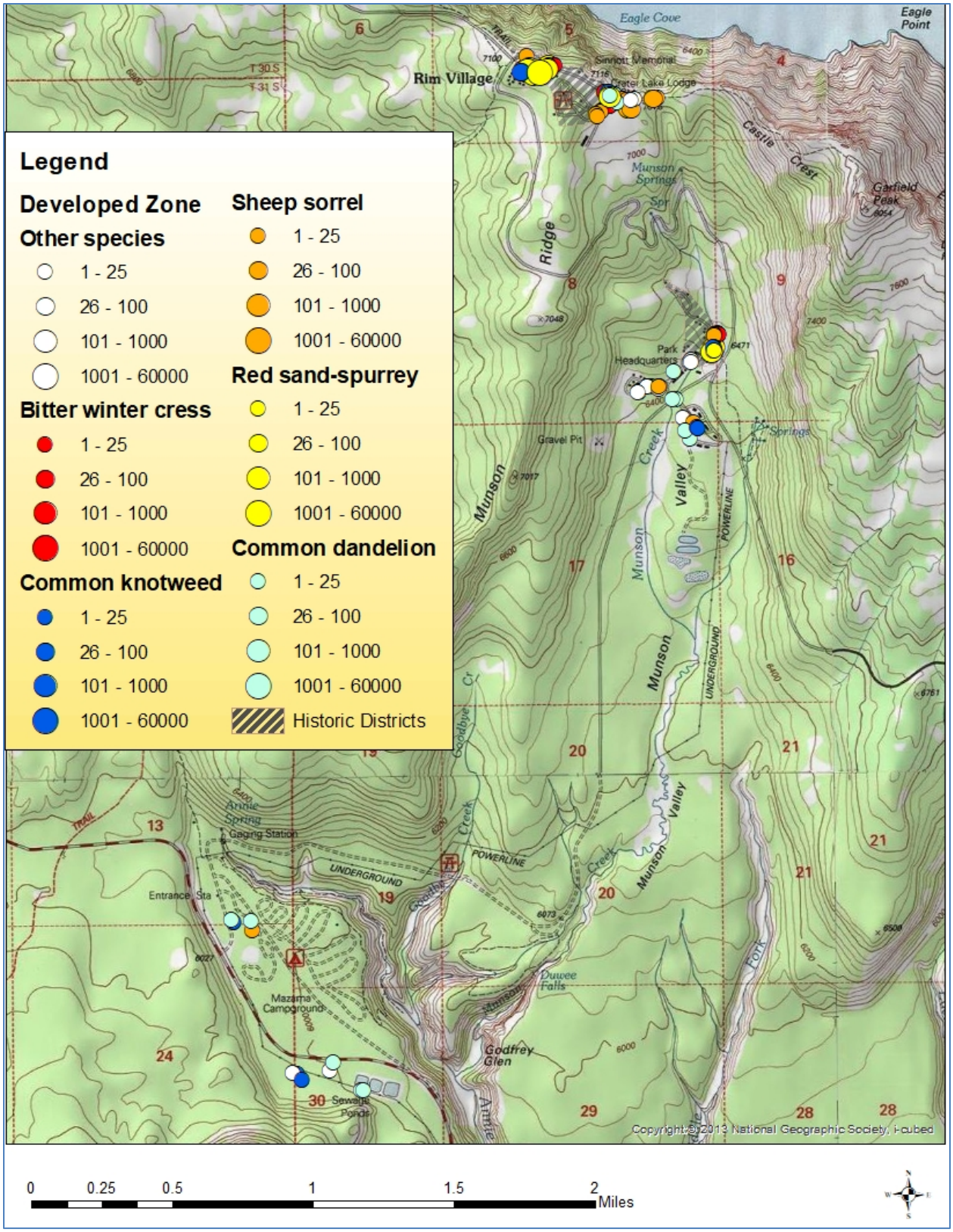

Figure 10. 2020 invasive plant populations in the Developed Zone. Map by Scott Heisler.

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 2020, a single crew member spent only one day surveying the lakeshore due to limitations in place by the Covid-19 pandemic. Surveys identified 54 individual invasive plants consisting of four different species in two different locations along the lakeshore (Figure 12; Tables 6-7).

The area east of Cleetwood Cove extending to Skell Head had the largest number of invasive plant species along the lakeshore in 2020. This is partly due to a newly discovered population of common groundsel *(Senecio vulgaris)* near the mooring buoy utilized by the lake research staff. Canada thistle (Figure 11) was also discovered at this location. The Watchman Bench area of the "Discovery Point to Merriam Point" region has historically had the largest diversity and number of invasive plant species in the lakeshore region. This was not the case in 2020; due to constraints on resources and time, much less area was surveyed. Invasive plant species found in 2020 in this area include Canada thistle, tansy ragwort, and hairy cat's ear *(Hypochaeris radicata)*.

In 2019 cheatgrass was discovered in the Cleetwood Cove to Skell Head region of the lakeshore. While finding any new invasive plant species within the caldera is cause for alarm, finding cheatgrass in this sensitive and extremely difficult-to-access area is by far the most alarming. Cheatgrass can establish a monoculture very quickly by going through multiple life cycles within one growing season. In 2020 this infestation point was a main focus for the day of lakeshore surveys; however, there was no cheatgrass discovered growing in or around the area where it was discovered in 2019.

Table 6. Number of invasive plants treated in the Lakeshore Zone from 2016-2020 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Lakeshore Zone IVM Region	2020	2019	2018	2017	2016
Cleetwood Cove to Skell Head	38	28	117	225	127
Skell Head to Eagle Point	*	*	0	*	0
Eagle Point to Discovery Point	*	*	0	0	338
Discovery Point to Merriam Point	16	156	469	15	203
Merriam Point to Cleetwood Cove	*	*	*	*	*
Wizard Island	*	14	0	13	5
Total	**54**	**198**	**586**	**253**	**606**

Table 7. Number of invasive plants treated in the Lakeshore Zone from 2016-2020 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2020	2019	2018	2017	2016
Cheatgrass (*Bromus tectorum*)	*	8	*	*	*
Canada thistle (*Cirsium arvensis*)	13	103	2	30	126
Bull thistle (*Cirsium vulgare*)	*	11	*	1	13
Jerusalem oak (*Dysphania botrys*)	*	*	*	2	*
St. John's wort (*Hypericum perforatum*)	*	*	408	210	31
Hairy cat's ear (*Hypochaeris radicata*)	2	15	*	*	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	*	*	*
Common groundsel (*Senecio vulgaris*)	36	*	*	*	*
Prickly sow thistle (*Sonchus asper*)	*	1	*	*	*
Common dandelion (*Taraxacum officinale*)	*	19	16	7	77
Yellow salsify (*Tragopogon dubius*)	3	1	*	3	30
Cowboy toilet paper (*Verbascum thapsus*)	*	14	*	*	0

Figure 11. Canada thistle growing along the shore of Crater Lake. Photo by Jen Hooke.

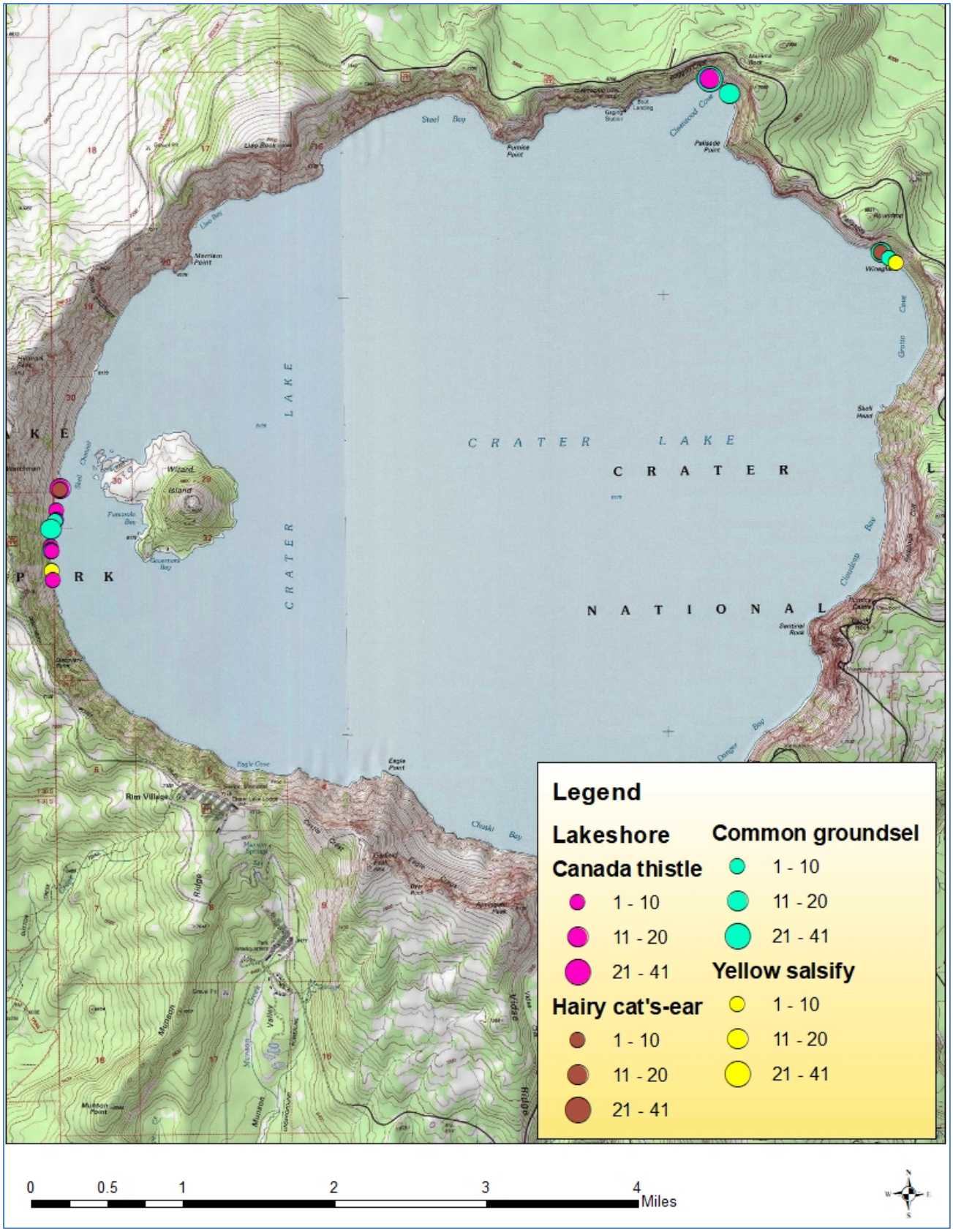

Figure 12. 2020 invasive plant populations in the Lakeshore Zone. Map by Scott Heisler.

Roadside Zone

Park roads (Figure 13) 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 2020, all roads within the Park were surveyed for invasive species. No invasive species were found or treated on Pinnacles Road and West Rim Drive in 2020, and Grayback Road (closed to public motor vehicle use) continues to remain free of invasive plant species. Twenty invasive plant species, totaling 12,170 individual plants, were treated along roadsides in 2020. Comparisons of roadside IVM regions surveyed and invasive plant species found during 2016 to 2020 field seasons are listed in Tables 8 and 9. Roadside locations of invasive plant species encountered in 2020 are displayed in Figure 15.

Figure 13. IVM crew members surveying roadside areas for invasive plants: surveying Pinnacles road (left – photo by Shane Palmer); surveying Munson Valley roadside (right – photo by Carrie Wyler).

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 (Figure 14), 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.

Rim Drive continues 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 although surveys were limited in 2020 due to the Covid-19 pandemic. 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 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 a small invasive plant infestation of field bindweed *(Convolvulus arvensis)* after the area 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. 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 cheatgrass 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 2020, 549 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. Three hundred forty-four individuals were treated in patches near the Annie Spring entrance station, 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 cheatgrass were discovered along Highway 62 south of the Park entrance and along Highway 138 in 2020. A total of 884 individuals were treated with only 29 of them being located along Highway 138. This is cause for concern as there have been no historic populations of cheatgrass along the southern portion of Highway 62 in recent years. Surveys along Highway 62

encountered populations of cheatgrass in May and June in various phenologic stages. In late June, one of the larger populations had been discovered to have already produced seed. This area along with the other cheatgrass populations should be focuses for spring 2021 in order to find and quickly treat any new and persisting populations. Well-established and abundant populations of other 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 with the latter two species not being treated at all in 2020.

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 in 2019. 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. The species was again found and treated in spring 2020.

Table 8. Number of invasive plants treated in the Roadside Zone from 2016—2020 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Roadside Zone IVM Region	2020	2019	2018	2017	2016
East Rim Drive	327	883	170	5,665	790
Highway 138	852	3,793	4,260	9,373	8,281
Munson Valley Road	1,387	1,966	3,547	4,649	3,692
North Entrance Road	9	149	0	160	126
Pinnacles Road	0	0	*	56	30
South Highway 62	8,637	5,517	11,723	24,212	12,441
West Highway 62	958	2,063	1,042	9,530	2,692
West Rim Drive	0	37	1	*	1,653
Total	**12,170**	**14,408**	**20,967**	**53,645**	**29,705**

Table 9. Number of invasive plants treated in the Roadside Zone from 2016—2020 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2020	2019	2018	2017	2016
Colonial bentgrass (*Agrostis capillaris*)	*	421	10	*	*
Redtop (*Agrostis gigantea*)	*	*	15	31	*
Meadow foxtail (*Alopecurus pratensis*)	6	1	83	*	*
Desert Alyssum (*Alyssum desertorum*)	46	38	*	*	*
Tall oatgrass *(Arrhenatherum elatius* var. *elatius*)	*	*	1	5	1
Yellow rocket (*Barbarea vulgaris*)	2	4	2	48	*
Canola (*Brassica napus*)	2	*	*	*	*
Field mustard (*Brassica rapa*)	*	*	1	*	*
Soft chess (*Bromus hordeaceus*)	*	*	*	*	1,659

Plant Species	2020	2019	2018	2017	2016
Smooth brome (*Bromus inermis*)	344	687	731	11,235	2,186
Cheatgrass (*Bromus tectorum*)	884	*	301	71	1,933
Shepherd's purse (*Capsella bursa-pastoris*)	*	*	*	*	*
Spotted knapweed (*Centaurea stoebe* ssp. *micranthos*)	*	21	12	33	58
Big chickweed (*Cerastium fontanum* ssp. *vulgare*)	*	*	*	*	*
Lambs quarters (*Chenopodium album*)	*	*	3	*	*
Rush skeletonweed (*Chondrilla juncea*)	4	1	2	5	3
Chicory (*Cichorium intybus*)	*	1	*	1	*
Canada thistle (*Cirsium arvensis*)	*	1	1	2	*
Bull thistle (*Cirsium vulgare*)	*	2	*	3	33
Field bindweed (*Convolvulus arvensis*)	4	3	9	15	20
Wild carrot (*Daucus carota*)	*	*	*	1	*
Tall orchardgrass (*Dactylis glomerata*)	*	10	*	*	30
Flixweed (*Descurainia sophia*)	*	*	*	*	1
Jerusalem oak (*Dysphania botrys*)	*	47	*	94	1,110
Quackgrass (*Elymus repens*)	*	422	*	*	425
African filaree (*Erodium cicutarium*)	*	*	*	*	*
Ivy bindweed (*Fallopia convolvulus*)	*	*	*	*	*
Red fescue (*Festuca rubra*)	*	50	*	*	*
Common velvetgrass (*Holcus lanatus*)	*	*	*	*	14
St. John's wort (*Hypericum perforatum*)	547	592	298	1,572	1,715
Hairy cat's ear (*Hypochaeris radicata*)	2	1	1	9	10
Dyer's woad (*Isatis tinctoria*)	*	*	*	31	*
Tall lettuce (*Lactuca canadensis*)	*	*	*	*	4
Prickly lettuce (*Lactuca serriola*)	*	3	*	*	*
Field pepperweed (*Lepidium campestre*)	*	*	16	*	*
Purple anther field pepperweed (*Lepidium heterophyllum*)	*	237	197	410	24
Oxeye daisy (*Leucanthemum vulgare*)	7	*	7	10	60
Perennial ryegrass (*Lolium perenne*)	*	*	*	*	*
Birdsfoot trefoil (*Lotus corniculatus*)	*	*	*	*	*
Pineapple weed (*Matricaria discoidea*)	*	*	*	60	1
White sweet clover (*Melilotus albus*)	*	*	*	*	1
Reed canarygrass (*Phalaris arundinacea*)	*	*	12	*	*
Timothy (*Phleum pratense*)	*	9	15	102	*
English plantain (*Plantago lanceolata*)	1	32	3	*	5
Common plantain (*Plantago major*)	*	*	1	31	5
Annual bluegrass (*Poa annua*)	100	*	*	40	115

Plant Species	2020	2019	2018	2017	2016
Bulbous bluegrass (*Poa bulbosa*)	4,275	2,616	6,423	9,251	2,340
Canada bluegrass (*Poa compressa*)	*	320	267	*	47
Kentucky bluegrass (*Poa pratensis*)	38	*	1,788	18	*
Common knotweed (*Polygonum aviculare* ssp. *depressum*)	*	3	*	296	30
Dog rose (*Rosa canina*)	*	*	*	*	1
Sheep sorrel (*Rumex acetosella*)	4,676	6,464	6,954	23,779	13,608
Russian thistle (*Salsola kali* ssp. *pontica*)	*	*	*	*	*
Tansy ragwort (*Senecio jacobaea*)	*	*	*	67	*
Woodland groundsel (*Senecio sylvaticus*)	1	*	5	*	1
Tall Fescue (*Schendonorus arundinaceus*)	*	38	*	*	*
Red sandspurry (*Spergularia rubra*)	*	10	28	*	1,799
Common tansy (*Tanacetum vulgare*)	*	*	1	*	*
Dandelion (*Taraxacum officinale*)	1,142	2,240	3,358	4,695	2,137
Pubescent wheatgrass (*Thinopyrum intermedium*)	*	*	75	*	*
Yellow salsify (*Tragopogon dubius*)	82	74	99	50	69
Scentless mayweed (*Tripleurospermum inodorum*)	*	*	*	*	1
Red clover (*Trifolium pratense*)	*	*	*	1	1
White clover (*Trifolium repens*)	*	54	30	1,642	188
Wheat (*Triticum aestivum*)	*	*	*	*	*
Cowboy toilet paper (*Verbascum thapsus*)	7	6	3	37	19

Figure 14. IVM crew member treating an invasive plant along Highway 62. Photo by Hamilton Hasty.

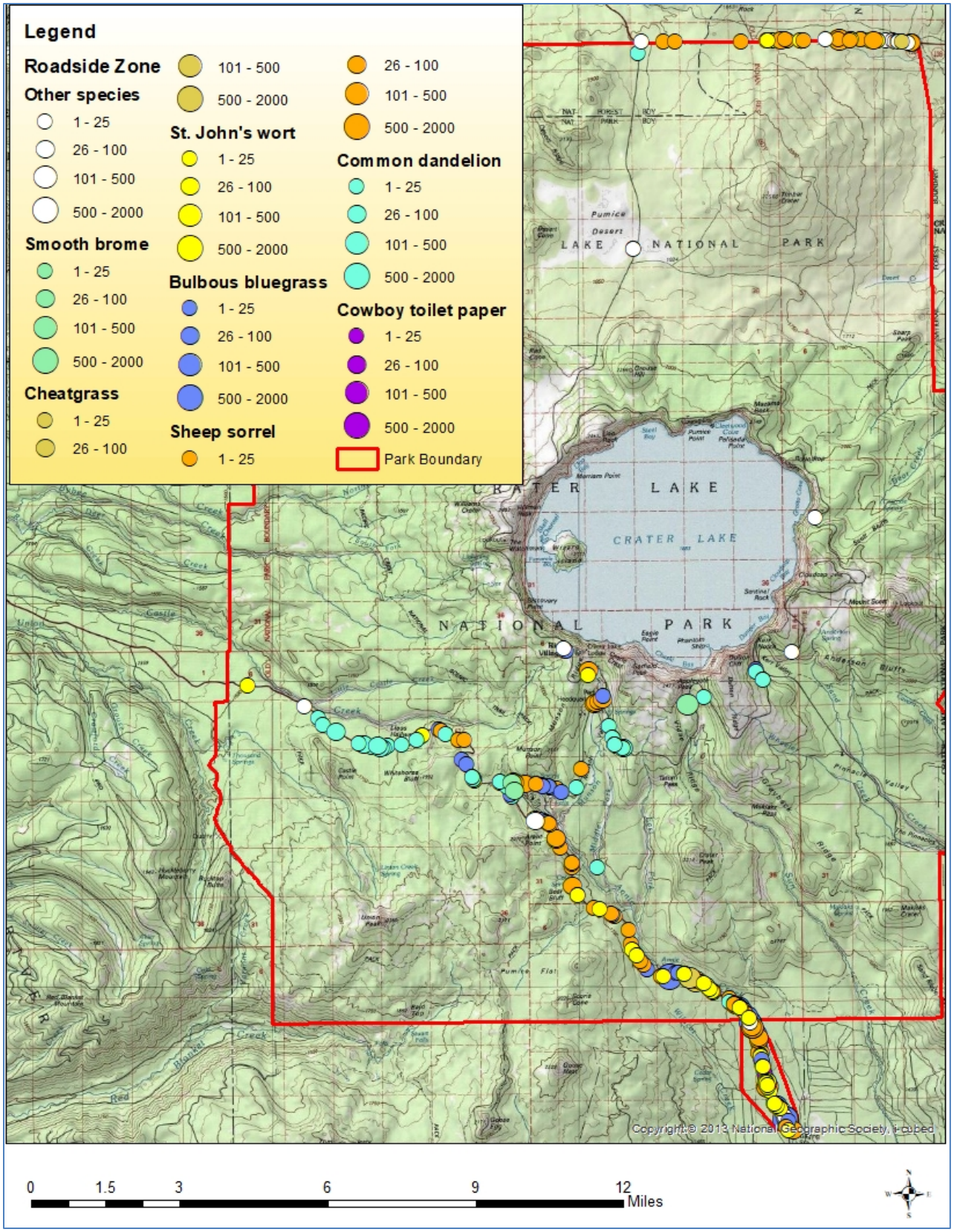

Figure 15. 2020 invasive plant populations in the Roadside Zone. Map by Scott Heisler.

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 (Figure 16), it is vital that the IVM program keeps these areas as free of invasive plants as possible. Staging area invasive plant locations encountered in 2020 are displayed in Figure 17. Comparisons with findings from the 2016 to 2020 field seasons are made in Tables 10 and 11.

In 2020, invasive plants were treated at three of the six staging areas: Pole Bridge Creek Quarry, South Yard, and the Ball Diamond. A total of 100 invasive plants were treated from seven species: yellow rocket, yellow salsify *(Tragopogon dubius)*, St. John's wort, cowboy toilet paper, red sand-spurrey, common dandelion and a new-to-CRLA invasive plant species sulfur cinquefoil *(Potentilla recta)* found at the Pole Bridge Creek Quarry.

Red sand-spurrey was the most abundant invasive plant species encountered in these areas. In 2019 populations of red sand-spurrey were discovered but not treated due to staffing constraints. These areas should be monitored in future field seasons to prevent spread of this invasive plant to other areas of the Park. Sulfur cinquefoil was discovered at Pole Bridge Creek Quarry near the "pumpkin," a water storage unit for the CRLA Fire program. This location has a high potential to spread this invasive plant species to areas of the Park where fire crews are working. As such, it is important to monitor and treat this population in future years to prevent the establishment of sulfur cinquefoil in backcountry regions of the Park.

Figure 16. Staging areas contain materials that are used widely across the Park. Photo by Jen Hooke.

Table 10. Number of invasive plants treated in the Staging Area Zone from 2016-2020 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Staging Area Zone IVM Region	2020	2019	2018	2017	2016
Anderson Quarry	0	7	47	1	73
Ball Diamond	50	*	0	1,420	*
Pole Bridge Creek Quarry	45	100	9	31	239
Roundtop Quarry	0	0	0	0	0
South Yard	5	52	5	74	16
Watchman Quarry	0	0	0	0	0
Total	**100**	**159**	**61**	**1,526**	**328**

Table 11. Number of invasive plants treated in the Staging Area Zone from 2016-2020 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2020	2019	2018	2017	2016
Burdock (*Arctium minor*)	*	*	*	*	*
Yellow rocket (*Barbarea vulgaris*)	4	107	9	11	300
Smooth brome (*Bromus inermis*)	*	*	*	5	*
Bull thistle (*Cirsium vulgare*)	*	*	1	4	*
Stinking pepperweed (*Lepidium ruderale*)	*	*	*	*	*
Yellow sweetclover (*Melilotus officinalis*)	*	45	*	*	*
Bulbous bluegrass (*Poa bulbosa*)	*	*	*	1	*
Sulfur cinquefoil *(Potentilla recta)*	20	*	*	*	*
St. John's wort (*Hypericum perforatum*)	8	*	*	*	5
Red sand-spurrey (*Spergularia rubra*)	50	*	*	1,432	6
Common dandelion (*Taraxacum officinale*)	13	*	*	9	4
Yellow salsify (*Tragopogon dubius*)	1	6	2	31	*
Cowboy toilet paper (*Verbascum thapsus*)	4	1	2	33	13

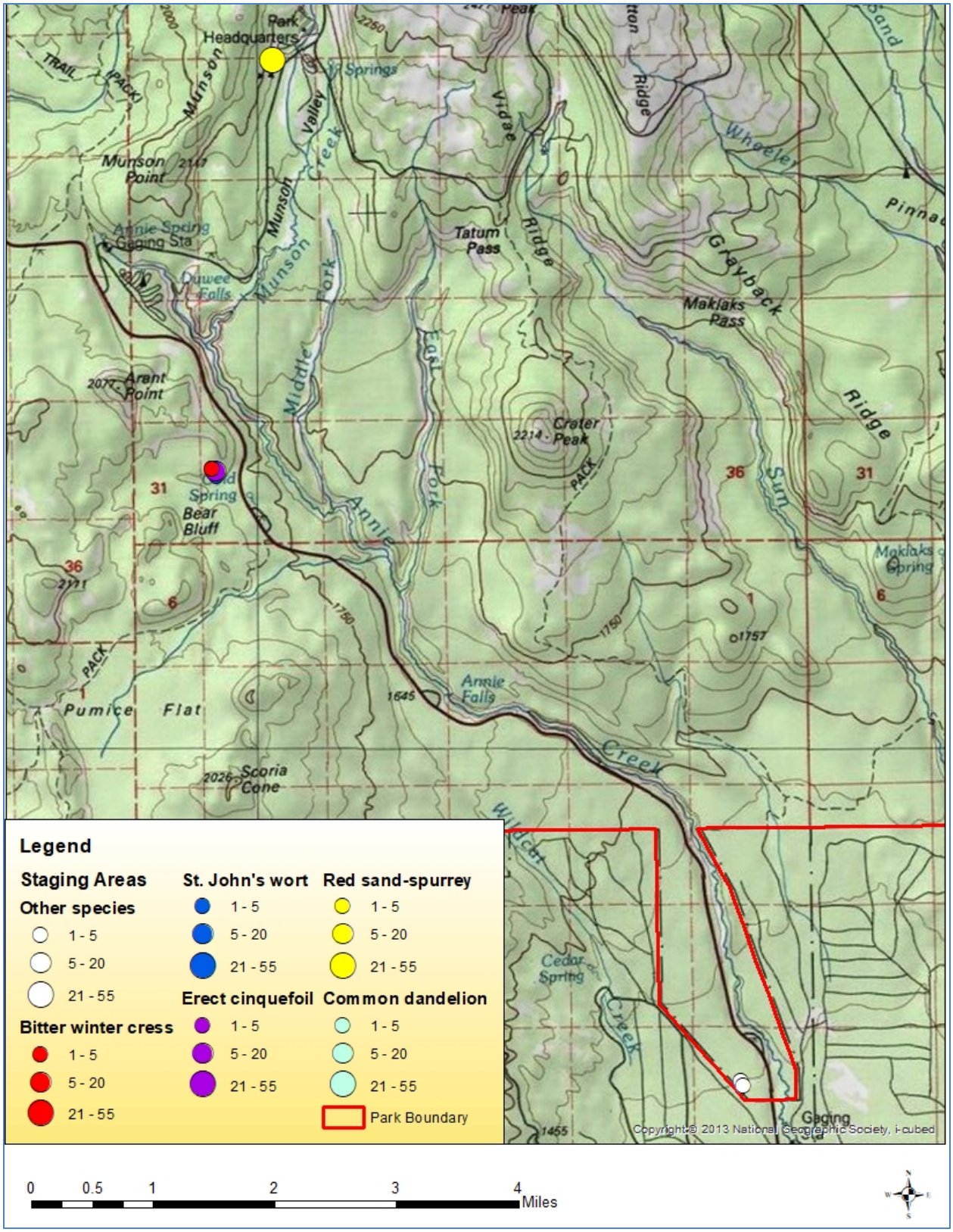

Figure 17. 2020 invasive plant populations in the Staging Areas Zone. Map by Scott Heisler.

Discussion

In 2020 there were no invasive plants found along West or East Rim Drives associated with Phase I of the Rim Drive Rehabilitation project (although surveys were limited due to the Covid-19 pandemic). As the Rim Drive Rehabilitation project progress it will become increasingly important to continue monitoring for invasive species along West and East Rim Drives especially as efforts are carried out to revegetate those areas. Another project being carried out in 2020 was the ongoing fuels reduction work carried out by the CRLA Fire Management program at Park headquarters, Mazama Village, and along the southern corridor of Highway 62. Surveys in following years should focus on the areas where pile burning occurred to prevent any invasive species becoming established in those recently disturbed areas. Highway 138 also experienced roadside grading in 2020 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. As the season progressed, however, many invasive plant species began to emerge, and subsequent surveys and treatments needed to be conducted. Among the species emerging from the disturbance was a new population of cheatgrass.

The 2020 IVM field season was greatly affected by the Covid-19 pandemic, primarily by reducing staff size and therefore the amount of area that could be surveyed and treated. Backcountry surveys were widely expanded in 2019 through the means of backcountry camping and resulted in numerous new invasive plant populations being discovered. The 2020 IVM crew was unable to conduct any backcountry camping trips due to work restrictions in place due to the Covid-19 pandemic. This limited or hampered access to many of the previous year's newly discovered populations and infestations around the Park and limited new areas accessible for survey. Namely, new-to-2019 infestations in the Spruce Lake and Bybee Creek fires were inaccessible and only a portion of new areas recommended for survey were able to be completed. The South Fork Copeland Creek drainage was able to be surveyed and yielded new populations of invasive plant species. As the mainstem of Copeland Creek was found to harbor many infestations in 2019 it will be prudent to survey the other forks and drainages of Copeland Creek in future years. This will most easily be accomplished using backcountry camping trips should the restrictions be lifted once again.

Areas of the Blanket Creek fire were inaccessible or not easily accessible in 2020 as well. This is partly due to downed trees blocking the access road leading to the Red Blanket Canyon area. In 2019 Red Blanket Canyon proved to be one of the most heavily infested areas in the Park with a very high diversity of invasive plant species. If possible, it will be prudent to conduct surveys in this area early in the 2021 season to monitor and treat known infestations that may have expanded due to a lack of treatment in 2020. Several new infestations were discovered in 2019 in the Blanket Creek Fire north of the canyon. Success was made in 2020 by reaching and treating many of those new populations; however, these surveys and treatments consumed several days due to traversing difficult terrain to reach these populations. Backcountry camping is highly recommended for IVM work in both areas when safety protocols allow. This would significantly increase the amount of area crew members could cover as well as reduce travel time, which would facilitate more effective work progress and greater IVM accomplishments.

Additional recommendations for IVM work in 2021 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 Cleetwood Cove to Skell Head area 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.
- 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 including new populations discovered in 2020 of sheep sorrel and St. John's wort.
- Crater Creek suffered from a significant increase in wall lettuce infestation in 2020. Efforts should be made to recheck the infestation in 2021 and expand surveys in search of more infestations.
- 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 are 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.
- If able, 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.
- Continue to manually treat desert alyssum at the Ponderosa Pine Picnic Area in early May and collect a flowering voucher specimen.
- Monitor Pole Bridge Creek Quarry and the South Yard for invasive plant species that may have been introduced with the Cherry Creek Pit gravel.
- Continue to walk West and East Rim Drives to survey for invasive plant establishment, as ability to do so was hampered by the Covid-19 pandemic.
- Ensure sufficient data are collected to meet regional IPM reporting requirements.

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April 2021

National Park Service
U.S. Department of the Interior

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