



Invasive Vegetation Management

2021 Annual Report



**ON THIS PAGE**

Invasive Vegetation Management crew member collects data on Wizard Island using an iPad with ArcGIS Collector. Photo by River Allen.

ON THE COVER

Invasive Vegetation Management crew searches for historic locations of invasive plant populations within the Spruce Lake Fire. Photo by River Allen.

Invasive Vegetation Management

2021 Annual Report

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P.O. Box 7
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April 2022

U.S. Department of the Interior
National Park Service
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.

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<https://irma.nps.gov/DataStore/Reference/Profile/2293229>

Please cite this publication as:

Von Bergman, A., H.L. Hasty, and J.S. Hooke. 2022. Invasive Vegetation Management: 2021 Annual Report. Crater Lake National Park, Crater Lake, Oregon.

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Acknowledgments

The 2021 Invasive Vegetation Management 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. Seasonal and temporary Botanical staff River Allen, David Larkin, Scott Heisler, and Carrie Wyler 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.

Introduction

The 2021 field season marked the nineteenth 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 some of the 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 2021 field season continued to be impacted by the Covid-19 pandemic. The planned number of IVM crew members could not be hired due to limitations in the number of employees who could be accommodated in Park housing. Despite having a smaller crew size, the 2021 field season was productive and informative for the Invasive Vegetation Management program. The crew consisted of four members, although two of them split their time with the CRLA Revegetation crew. This was the fifth 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.

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 area impacted by the 2018 Timber Crater 6 fire. The entirety of the Timber Crater 6 fire was surveyed this year. 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; it is hoped the interns can assist with IVM work starting in the 2022 field season.

The Park received 306 inches of snow over the 2020—2021 winter, which is approximately 64% of the average snowfall of 481 inches. The Park was in extreme drought conditions for the duration of the 2021 field season. Park headquarters (~6,400' elevation) experienced snow-free conditions on May 26. Field work commenced on May 12 and ended on October 19. There were several large fires surrounding the Park that contributed to poor air quality for several weeks during the months of August and September that limited the crew's ability to complete assigned field work. Large Park projects causing ground disturbance were limited to continuing fuel break and defensible space creation by the CRLA Fire Management program near Park headquarters, Mazama Village, and along the southern Highway 62 corridor.

Methods

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

Vegetation surveys consist of visually searching a region for invasive plants (Figure 1), typically on foot but occasionally via boat or automobile. The IVM crew navigates to known invasive plant locations with the aid of GPS units, and in most instances uses a grid formation to survey for invasive plants. This entails the crew lining up and spacing out so there are no gaps in the field of vision between crew members; the width between crew members can vary based on terrain and vegetation structure. The line is led by a crew member on the end who navigates with a GPS unit, and as crew members visually search the area for 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. An IVM crew member hiking over obstacles in search of historic invasive plant populations. Photo by River Allen.

Once an invasive plant population is discovered, data are recorded including scientific name, region where it was found, total number of plants present, area that plants occupy (m²), and treatment applied to the population. Data are input into 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 (Figure 2). 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. New-to-CRLA dog-fennel is collected from Highway 62 to become a voucher for the Park's herbarium. Photo by Alexandra von Bergman.

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

After the Invasive Vegetation Management Plan was approved in July 2017, the IVM crew started using herbicide as a treatment option. Although many invasive plant species can be successfully treated by hand pulling alone, large populations or species with persistent roots (e.g., deep tap-roots of common dandelion –*Taraxacum officinale*; rhizomes of Canada thistle –*Cirsium arvense*, sheep sorrel –*Rumex acetosella*, and smooth brome –*Bromus inermis*; and extensive fibrous roots of St. John’s wort –*Hypericum perforatum*) are most effectively treated with herbicide. Ten herbicides are approved for use in the Park, with five herbicides submitted and approved for use through the NPS Pesticide Use Permitting System (PUPS) in 2021 (Table 1).

Table 1. Herbicides approved for use under the CRLA Invasive Vegetation Management Plan. Bold type indicates herbicides approved for use in 2021 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, then loaded into a truck bed for transport to the field site. Occasionally, a small bottle of herbicide concentrate would be transported to the field in a truck lockbox if the need to mix more herbicide formulation was anticipated. The crew utilized both backpack and hand sprayers for chemical control. Backpack sprayers are more traditionally used for herbicide application; however, CRLA contains very few invasive plant monocultures, thus hand sprayers generally have sufficient capacity (Figure 3). Hand sprayers have the advantage of being far more portable than backpack sprayers and allow the applicator to carry a normal backpack while working.



Figure 3. An IVM crew member uses a hand sprayer to spray a Canada thistle patch with herbicide. Photo by River Allen.

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 Collector on the iPad, as well as navigation. Any herbicide left behind is locked in a box in the truck bed.

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

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 12 – October 19, 2021. Approximately 77,560 invasive plants were controlled during the 2021 field season, including two non-native plant species that had not been previously recorded within CRLA: dog-fennel (*Anthemis cotula*) and hairy bittercress (*Cardamine hirsuta*). This brings the number of non-native plant species documented within CRLA to 92; however, 35 of those species have not been encountered within the Park in recent years. Control efforts put forth by the 2021 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 25,734 invasive plants were treated in the Park's backcountry areas during the 2021 field season (Figure 8; 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. Additionally, the west side of the Park has experienced multiple large fires since 2015. Due to these factors, the west side of the Park generally harbors more invasive plant infestations than the east side.

Regardless of an active fire season that caused poor air quality conditions and a smaller crew size due to COVID-19 restrictions, the IVM crew surveyed nearly all planned areas during the 2021 field

season. However, the smaller crew size did not allow thorough surveying/treatment of problem sites, limited the ability to survey new sites, and did not allow any follow-up treatment work this season. The crew mainly focused on treating known invasive plant populations and, when time allowed, new areas were also surveyed. New infestations were located within the Bybee Creek Fire, National Creek Complex, Timber Crater, and Godfrey Glen trail areas. Backcountry camping was utilized this season to focus on the Blanket Creek fire's extensive invasive plant infestations. Unfortunately, the trip was cut short due to hazardous air quality from nearby fires.

In 2021, the Blanket Creek fire harbored some of the largest invasive plant infestations (Figure 4) in the Park, with the exceptions being Rim Village and Poison Meadows. For reporting purposes, the Red Blanket Canyon and the Blanket Creek fire have been separated into two 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 (Figure 5). Due to air quality concerns and lack of time, only two days were spent surveying and treating infestations in Lower Red Blanket Canyon. Several days were spent surveying and treating



Figure 4. An IVM crew member stands amid a large infestation of cowboy toilet paper before manually treating the population. Photo by River Allen.

infestations in the upper portion of the Blanket Creek fire to cover large expanses of the region. Approximately 5,106 invasive plants consisting of eight different plant species were treated in this portion of the fire alone.

The invasive plant species that were most prevalent throughout the region, as well as found in greatest abundance, were cowboy toilet paper (*Verbascum thapsus*), Canada thistle, and bull thistle (*Cirsium vulgare*). There have been cheatgrass infestations previously found in the Red Blanket Canyon, but none were found during the 2021 season. The cowboy toilet paper and bull thistle populations located farthest to the east appeared to have increased in severity. Long days of hiking are required to reach these populations and with poor air quality affecting the park for over two months, it was not possible to give this area as much focus as was needed. With a larger crew and more time in the field, these populations could become manageable in the future.



Figure 5. An IVM crew member climbs the steep slopes of the floristically diverse Red Blanket Canyon. Photo by River Allen.

Surveys in four burned areas within the Backcountry zone produced decreased invasive plant species counts: the Blanket Creek fire, the Spruce Lake fire, the Castle fire, and the Upper Panhandle burn unit/Baboon fire. In the Blanket Creek and Spruce Lake fire areas, known and historically treated invasive plant populations yielded far fewer numbers than previous years. Although one large and

unmanageable invasive plant population went untreated in the Blanket Creek fire, most populations in the area were showing improvement. This positive response could be due to continual treatment throughout the years, or it could be a result of extreme drought conditions. In the Castle fire and Upper Panhandle burn unit/Baboon fire areas invasive plant population numbers decreased by 66% and 96%, respectively, compared to 2020 findings of the same invasive plant populations in the same locations.

Three burned areas produced increased invasive plant species counts: the Bybee Creek fire, the Crescent fire, and the Timber Crater fire. Additional areas of the Bybee Creek fire were surveyed this year where no previous invasive plant populations had been documented thanks to reports from CRLA Wildlife crew members. These additional populations as well as sites surveyed earlier in the season produced a 3.7% increase in invasive plant species detected compared with the 2020 field season. In the 2015 Crescent fire located in the National Creek Complex several new invasive plant populations were discovered in areas that were previously unsurveyed. These new invasive plant populations represent the biggest increase in numbers of invasive plants of any region in the Backcountry zone at 730% more plants found than during the 2020 field season. The final increase in invasive plant species counts was found in the Timber Crater fire. This marks the first year that invasive plants were found in the area burned by the 2018 fire; however, only three plants were encountered.

Invasive vegetation management within the Park's wetland and meadow systems was more productive this year. Typically, for large portions of the year these areas (e.g., Cottonwood Meadows, Spruce Lake) contain too much standing water to apply herbicide and as water recedes throughout the season, native vegetation growth is often so dense as to make herbicide application challenging. However, during the 2021 field season, both Cottonwood Meadows and Spruce Lake were entirely dried up (Figure 6). The extremely low water levels made surveying Spruce Lake easier and spraying Canada thistle growing in the middle of the dry lakebed was now possible. The ability to survey more ground resulted in 67% more invasive plants controlled at Spruce Lake and 148% more invasive plants treated at Thousand Springs compared to the 2020 season.

Poison Meadows, while showing a positive response to invasive plant treatment, continues to be a 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 meadows make for a constantly changing matrix of invasive plant populations. Time was allotted this field season to control new populations of sheep sorrel and St. John's wort that were discovered and left untreated during the 2020 field season. Yellow salsify (*Tragopogon dubius*) continues to have a strong presence at Poison Meadows; thankfully the Northwest Youth Corps (NYC) was able to help remove almost two thousand individuals this season. With the help of the NYC and the control of the newly discovered invasive plant populations, the number of invasive plants controlled in Poison Meadows increased by 41% compared to 2020 efforts.



Figure 6. The IVM crew surveying the completely dry Spruce Lake. Photo by Alexandra von Bergman.

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 2021, surveys of this region mainly took place in June, and it was unusually dry for that time of year. The dry ground made manual control of the large common dandelion populations difficult and slow. Plans to return and treat with herbicide were made, but time restraints and higher priority areas made returning not possible.

The riparian areas surveyed within the park in 2021 were Annie Creek, Lower Castle Creek, Copeland Creek, Crater Creek, Munson Creek, National Creek, Pothole Creek, and Sun Creek. Nearly every site had an increase in invasive plant populations, the most prevalent plant species being common dandelion as it thrives in moist environments. The invasive plant situation at Crater Creek improved with decreasing bull thistle abundance compared with 2020, and the wall lettuce (*Mycelis muralis*) patches that received herbicide treatment in 2020 also were reduced in size. Follow-up herbicide treatment of the wall lettuce was not accomplished this season; however, a large patch was controlled manually to help reduce population size.

Surveys in Annie Creek continue to detect robust invasive plant populations in 2021. Bull thistle populations slightly decreased in size, although new Canada thistle patches were found. Additionally, historic sheep sorrel patches returned this year, but were at a manageable size (Figure 7). Overall, invasive plant abundance increased by 47% compared to the 2020 field season.



Figure 7. The IVM crew members work together to find and treat sheep sorrel found beside Annie Creek. Photo by Alexandra von Bergman.

The steep meadow 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*), prickly sow thistle (*Sonchus asper*), and tall lettuce (*Lactuca canadensis* – though none was found 2021). Common mouse-ear chickweed was not found in 2020, nevertheless populations exploded since then. Approximately 325 common mouse-ear chickweed plants were controlled; however, this represented a fraction of the entire population which was mostly left untreated due to time constraints. Additional control of common mouse-ear chickweed will need to occur in future field seasons. Populations of bull thistle responded positively to treatment and decreased in abundance in 2021 compared to previous years.

Table 2. Number of invasive plants treated in the Backcountry Zone from 2017—2021 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Backcountry Zone IVM Region	2021	2020	2019	2018	2017
Annie Creek	412	279	493	1,092	4,025
Blanket Creek Fire	5,106	13,936	15,200	3,892	*
Bybee Creek – Lower	*	188	4,160	*	*
Bybee Fire	730	704	2,267	626	699
Castle Creek – Lower	959	744	1,701	843	1,655
Castle Creek – North Fork	*	0	*	*	180
Castle Crest Wildflower Garden	3	0	0	*	12
Castle Fire	41	124	226	2,102	1,155
Copeland Creek	3	*	60	*	*
Cornerstone Burn Unit	0	0	0	*	0
Crater Creek	1,514	30,642	8,881	775	759
Desert Ridge Fire (NCC)	24	110	625	111	365
Godfrey Glen	1	*	*	*	*
Munson Creek	467	*	430	*	*
National Creek	1,036	279	*	241	2,738
National Creek Complex	3,588	432	1,844	1,036	2,547
Panhandle – Interior	0	0	0	40	*
Panhandle – Cottonwood Meadow	682	2,015	3,105	2,552	2,255
PH3 Burn Unit	10	*	14	14	1
Poison Meadows	6,118	4,834	10,068	15,632	17,187
Pothole Creek	130	0	0	*	391
Pumice Complex	1	3	0	2	*
Red Blanket Canyon	791	*	20,857	960	2,809
Sand Creek	*	0	14	*	*
Scoria Fire	120	39	65	1	*
Spruce Lake	1,104	659	1,013	1,300	0
Spruce Lake Fire	459	3,274	2,581	3,008	*
Sun Creek	1,058	0	3,968	2,500	8,942
Thousand Springs (North & South)	1,374	552	2,876	6,076	3,800
Timber Crater	3	0	0	*	*
Upper Panhandle Burn Unit/Baboon	3	95	1,120	5,880	1,519
Total	25,734	58,909	81,628	48,683	51,024

Table 3. Number of invasive plants treated in the Backcountry Zone from 2017—2021 by plant species. Asterisks (*) denote species that weren't encountered or treated in a particular year.

Plant Species	2021	2020	2019	2018	2017
Redtop (<i>Agrostis gigantea</i>)	*	*	72	*	*
Meadow foxtail (<i>Alopecurus pratensis</i>)	*	*	1	*	*
Yellow rocket (<i>Barbarea vulgaris</i>)	4	238	*	*	*
Smooth brome (<i>Bromus inermis</i>)	*	*	*	10	*
Cheatgrass (<i>Bromus tectorum</i>)	*	12	*	*	*
Common mouse-ear chickweed (<i>Cerastium fontanum</i> ssp. <i>vulgare</i>)	324	*	219	*	*
Canada thistle (<i>Cirsium arvensis</i>)	1,046	635	1,113	1,454	4,091
Bull thistle (<i>Cirsium vulgare</i>)	1,311	3,440	13,334	8,396	7,554
Tall orchardgrass (<i>Dactylis glomerata</i>)	30	*	15	*	*
Jerusalem oak (<i>Dysphania botrys</i>)	*	*	*	*	20
St. John's wort (<i>Hypericum perforatum</i>)	495	136	704	1,836	54
Hairy cat's ear (<i>Hypochaeris radicata</i>)	56	4	99	127	*
Dyer's woad (<i>Isatis tinctoria</i>)	*	*	*	*	74
Tall lettuce (<i>Lactuca canadensis</i>)	*	16	41	*	822
Prickly lettuce (<i>Lactuca serriola</i>)	728	169	1,228	671	229
Wall lettuce (<i>Mycelis muralis</i>)	1,995	30,040	8,156	399	*
Reed canarygrass (<i>Phalaris arundinacea</i>)	*	*	3,008	1,374	1,090
Timothy (<i>Phleum pratense</i>)	398	200	943	2,702	2,580
Annual bluegrass (<i>Poa annua</i>)	*	*	*	*	10
Sheep sorrel (<i>Rumex acetosella</i>)	3,072	838	2,317	4,257	8,999
Curly dock (<i>Rumex crispus</i>)	*	*	14	*	*
Tansy ragwort (<i>Senecio jacobaea</i>)	1	*	3	421	10
Woodland groundsel (<i>Senecio sylvaticus</i>)	75	5,611	19,957	4,267	43
Common groundsel (<i>Senecio vulgaris</i>)	38	*	*	50	*
Prickly sow thistle (<i>Sonchus asper</i>)	111	104	318	185	1
Red sand-spurrey (<i>Spergularia rubra</i>)	*	*	*	200	*
Common dandelion (<i>Taraxacum officinale</i>)	5,665	2,468	13,131	12,274	17,565
Yellow salsify (<i>Tragopogon dubius</i>)	3,427	3,615	5,660	8,337	7,558
White clover (<i>Trifolium repens</i>)	*	1,099	325	85	235
Cowboy toilet paper (<i>Verbascum thapsus</i>)	6,958	10,484	10,910	1,638	89

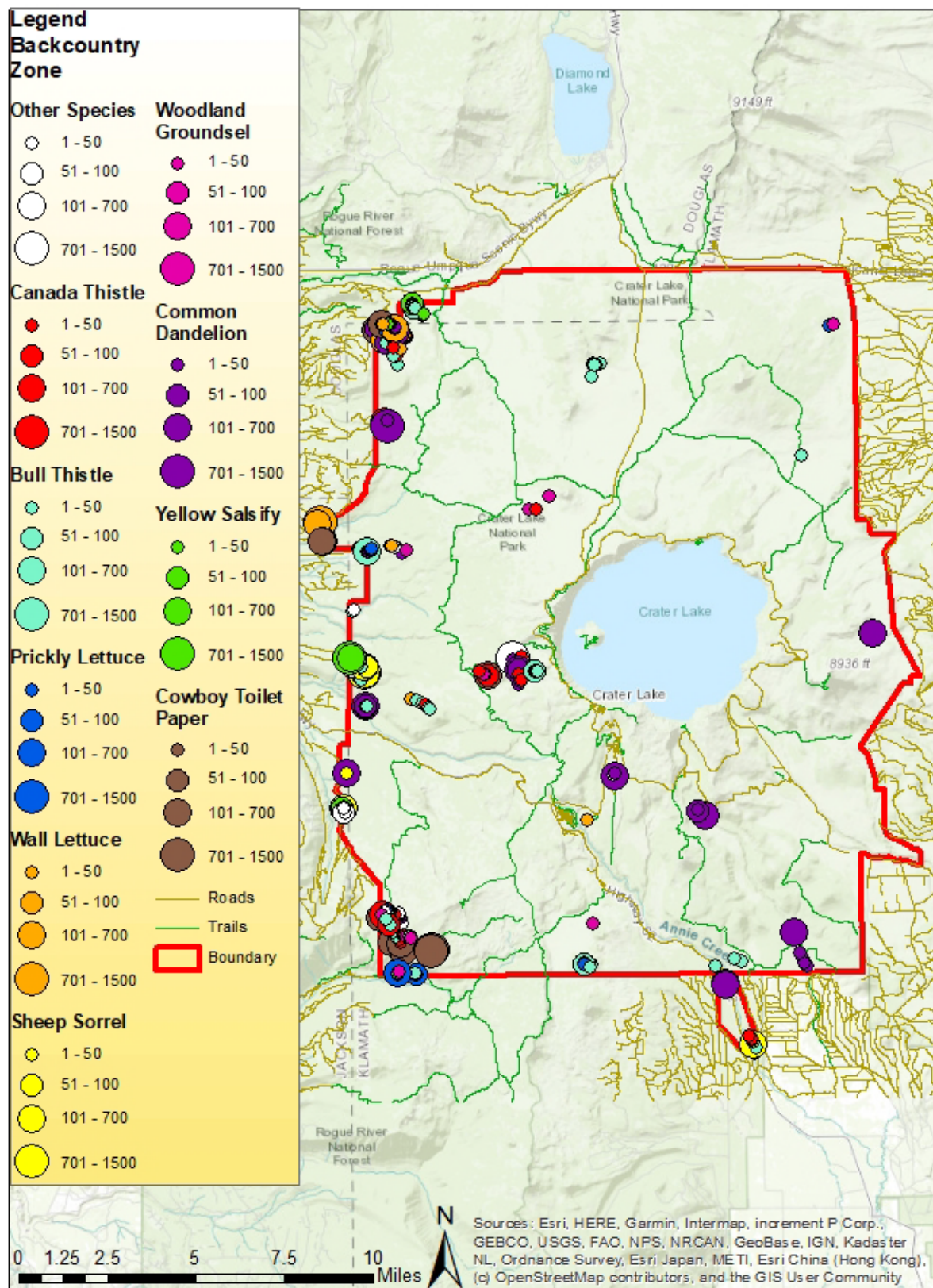


Figure 8. 2021 invasive plant populations in the Backcountry Zone. Map by Alexandra von Bergman and Hamilton Hasty.

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 2021, 35,562 individuals of 19 different invasive plant species were controlled in the Park's developed areas (Figure 12). Comparison with findings from the 2017 - 2021 field seasons are made in Tables 4 and 5. The decrease in total numbers of invasive plants treated in 2021 was primarily due to sheep sorrel abundance decreasing with consistent herbicide treatment and red sand-spurrey (*Spergularia rubra*) treatment occurring only within active restoration project areas leaving other populations of red sand-spurrey untreated.

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* – Figure 11), sheep sorrel, and red sand-spurrey were the most frequently encountered invasive plant species. These species thrive in compacted soils and pavement crevices found throughout the developed zone (Figure 10).



Figure 9. Red sand-spurrey growing out of the pavement in the Annie Creek Restaurant parking lot after being sprayed with a blue herbicide mixture. Photo by Alexandra von Bergman.

Yellow rocket (*Barbarea vulgaris*) has experienced a decrease in population size from 213 individuals treated in 2020 to only 24 individuals encountered and treated in 2021. Common hound's tongue, a species newly occurring within the Park in 2019, was not found in 2021. Timothy grass (*Phleum pratense*) was found growing outside employee housing (Sleepy Hollow) for the first time.

A smooth brome infestation outside of Sleepy Hollow (Figure 10) increased in size this year. In 2020 common knotweed populations had a decrease in population size; however, this year they increased by 139%. Common knotweed was most often found in pavement cracks in the Rim Village and Mazama Village parking lots.

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



Figure 10. An IVM crew member sprays smooth brome in the Park housing area. Photo by Hamilton Hasty.

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 2020 the sheep sorrel population consisted of approximately 1,300 plants, all of which were treated

with herbicide. In 2021 that same population numbered approximately 995 plants, a 23% reduction in population size. This was also treated in its entirety in 2021.

Table 4. Number of invasive plants treated in the Developed Zone from 2017-2021 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Developed Zone IVM Region	2021	2020	2019	2018	2017
Headquarters/Housing	3,770	7,728	4,908	3,797	8,520
Lost Creek Campground	48	0	0	0	0
Mazama Campground	1,743	0	629	118	0
Mazama Dorms	304	174	43	3	1,048
Mazama Village	2,685	167	2,450	51	594
Rim Village	27,012	33,026	75,872	14,708	46,052
Total	35,562	41,095	83,902	18,677	56,214

Table 5. Number of invasive plants treated in the Developed Zone from 2017-2021 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2021	2020	2019	2018	2017
Redtop (<i>Agrostis gigantea</i>)	15	282	*	*	*
Meadow Foxtail (<i>Alopecurus pratensis</i>)	*	*	5	30	*
Yellow rocket (<i>Barbarea vulgaris</i>)	24	213	311	175	675
Smooth brome (<i>Bromus inermis</i>)	45	30	484	*	30
Cheatgrass (<i>Bromus tectorum</i>)	*	1	*	*	*
Diffuse knapweed (<i>Centaurea diffusa</i>)	1	*	*	*	*
Common mouse-ear chickweed (<i>Cerastium fontanum</i> ssp. <i>vulgare</i>)	*	*	*	1	*
Rush skeletonweed (<i>Chondrilla juncea</i>)	*	*	1	*	*
Chicory (<i>Cichorium intybus</i>)	*	*	1	*	*
Canada thistle (<i>Cirsium arvensis</i>)	*	*	*	*	10
Bull thistle (<i>Cirsium vulgare</i>)	*	*	*	*	1
Common hound's tongue (<i>Cynoglossum officinale</i>)	*	*	1	*	*
Tall orchardgrass (<i>Dactylis glomerata</i>)	1	*	*	1	12
Broadleaf cottonrose (<i>Filago pyramidata</i> var. <i>pyramidata</i>)	*	*	*	500	1025
St. John's wort (<i>Hypericum perforatum</i>)	*	11	1	9	11
Stinking pepperweed (<i>Lepidium ruderales</i>)	*	*	19	*	*
Birdsfoot trefoil (<i>Lotus corniculatus</i>)	*	*	*	*	1
Pineapple weed (<i>Matricaria discoidea</i>)	6	7	582	1,615	729

Plant Species	2021	2020	2019	2018	2017
Yellow sweet clover (<i>Melilotus officinalis</i>)	*	*	1	*	1
Timothy (<i>Phleum pratense</i>)	2	*	*	*	*
English plantain (<i>Plantago lanceolata</i>)	2	2	3	1	3
Common plantain (<i>Plantago major</i>)	10	*	6	2	27
Annual bluegrass (<i>Poa annua</i>)	1,316	113	351	*	140
Bulbous bluegrass (<i>Poa bulbosa</i>)	*	161	*	*	1
Canada bluegrass (<i>Poa compressa</i>)	*	*	*	250	*
Common knotweed (<i>Polygonum aviculare</i> ssp. <i>depressum</i>)	6,212	2,598	6,180	305	1,019
Sheep sorrel (<i>Rumex acetosella</i>)	2,041	3,427	1,991	7,288	26,528
Curly dock (<i>Rumex crispus</i>)	1	*	*	*	25
Woodland groundsel (<i>Senecio sylvaticus</i>)	6	*	*	*	*
Red sand-spurrey (<i>Spergularia rubra</i>)	25,510	34,126	73,236	8,103	24,717
Common dandelion (<i>Taraxacum officinale</i>)	273	109	600	294	713
Yellow salsify (<i>Tragopogon dubius</i>)	1	*	*	1	*
Dutch clover (<i>Trifolium repens</i>)	95	1	*	*	*
Cowboy toilet paper (<i>Verbascum thapsus</i>)	1	*	*	*	*



Figure 11. Common knotweed colonizing pavement cracks in a parking lot at Mazama Village. Photo by Carrie Wyler.

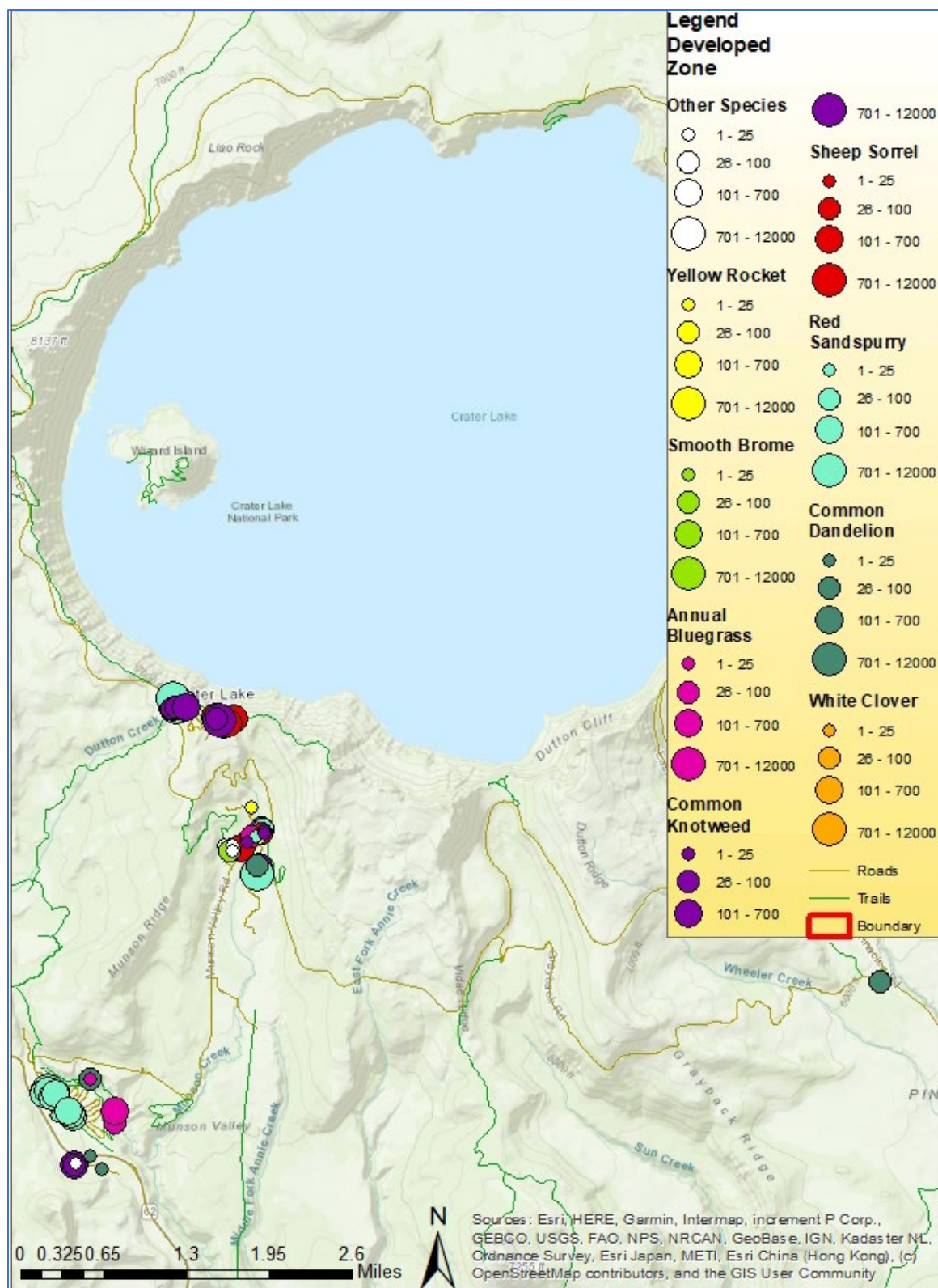


Figure 12. 2021 invasive plant populations in the Developed Zone. Map by Alexandra von Bergman and Hamilton Hasty.

Lakeshore Zone

The shore of Crater Lake is the most difficult region of the Park to survey 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 surveying difficult. Timing is also paramount for the treatment of perennial or rhizomatous invasive plants to be effective. In 2021, the IVM crew spent four days surveying the lakeshore including Wizard Island (Figure 13) and Phantom Ship. Surveys identified 1,933 individuals of 13 invasive plant species in five different areas along the lakeshore (Tables 6-7, Figure 15).



Figure 13. Two IVM crew members survey the shore of Wizard Island for invasive plants. Photo by Alexandra von Bergman.

The Watchman Bench area of the “Discovery Point to Merriam Point” region contains the largest diversity and number of invasive plant species along the lakeshore as well as some of the most persistent invasive plant populations (Figure 13). Approximately 1,600 invasive plants were found in this region alone, which is significantly more than previous years. Both the cowboy toilet paper and Canada thistle populations along the bench have persevered through consistent treatment for over a decade. Cowboy toilet paper populations are showing a 42% decline from 2019, however Canada

thistle infestations have risen 22% since 2019. Populations of woodland groundsel (*Senecio sylvaticus*), common groundsel (*Senecio vulgaris*), and hairy cat's ear (*Hypochaeris radicata*) have increased in this area since 2019. This could be due to historic lows in water levels exposing more lakeshore to colonization since all of these invasive plant species are primarily wind-dispersed.

Fortunately, there was no cheatgrass (*Bromus tectorum*) discovered growing in or around the Wineglass area where it was discovered in 2019. However, prickly sow thistle continues to be found after its discovery in 2019 and has slightly increased in abundance. A new invasive plant discovery of lesser concern was a single individual of red sand-spurrey, which was found along the “Discovery Point to Merriam Point” region. Another new occurrence was a single common groundsel growing on the rocky shore of Phantom Ship (Figure 14), which marks the first time non-native plants have been documented from this unique feature.



Figure 14. Left: Two IVM crew members consult an iPad for historic invasive plant populations in the Watchman Bench area. Photo by Carrie Wyler. Right: An IVM crew member removes common groundsel on Phantom Ship. Photo by Hamilton Hasty.

More invasive plants were found this year at the “Cleetwood Cove to Skell Head” and Wizard Island regions than in the past four years. The 2020 field season was extremely limited in time and resources due to the COVID-19 pandemic compared to the 2021 field season. This year more time and crew members were available to survey the lakeshore. This resulted in a complete survey of Wizard Island and the “Cleetwood Cove to Skell Head” region. These factors combined with low

water levels resulted in a significantly higher number of invasive plants discovered and controlled on the lakeshore than over the past four years combined.

Table 6. Number of invasive plants treated in the Lakeshore Zone from 2017-2021 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Lakeshore Zone IVM Region	2021	2020	2019	2018	2017
Cleetwood Cove to Skell Head	235	38	28	117	225
Skell Head to Eagle Point	*	*	*	0	*
Eagle Point to Discovery Point	21	*	*	0	0
Discovery Point to Merriam Point	1,595	16	156	469	15
Merriam Point to Cleetwood Cove	*	*	*	*	*
Phantom Ship	1	*	*	*	*
Wizard Island	81	*	14	0	13
Total	1,933	54	198	586	253

Table 7. Number of invasive plants treated in the Lakeshore Zone from 2017-2021 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2021	2020	2019	2018	2017
Cheatgrass (<i>Bromus tectorum</i>)	*	*	8	*	*
Canada thistle (<i>Cirsium arvensis</i>)	126	13	103	2	30
Bull thistle (<i>Cirsium vulgare</i>)	55	*	11	*	1
Jerusalem oak (<i>Dysphania botrys</i>)	*	*	*	*	2
St. John's wort (<i>Hypericum perforatum</i>)	6	*	*	408	210
Hairy cat's ear (<i>Hypochaeris radicata</i>)	100	2	15	*	*
Prickly lettuce (<i>Lactuca serriola</i>)	22	*	*	*	*
Wall lettuce (<i>Mycelis muralis</i>)	2	*	3	*	*
Kentucky bluegrass (<i>Poa pratensis</i>)	*	*	*	16	*
Sheep sorrel (<i>Rumex acetosella</i>)	*	*	*	144	*
Tansy ragwort (<i>Senecio jacobea</i>)	*	*	2	*	*
Woodland groundsel (<i>Senecio sylvaticus</i>)	859	*	21	*	*
Common groundsel (<i>Senecio vulgaris</i>)	723	36	*	*	*
Prickly sow thistle (<i>Sonchus asper</i>)	4	*	1	*	*
Red sand-spurrey (<i>Spergularia rubra</i>)	1	*	*	*	*
Common dandelion (<i>Taraxacum officinale</i>)	18	*	19	16	7
Yellow salsify (<i>Tragopogon dubius</i>)	9	3	1	*	3
Cowboy toilet paper (<i>Verbascum thapsus</i>)	8	*	14	*	*

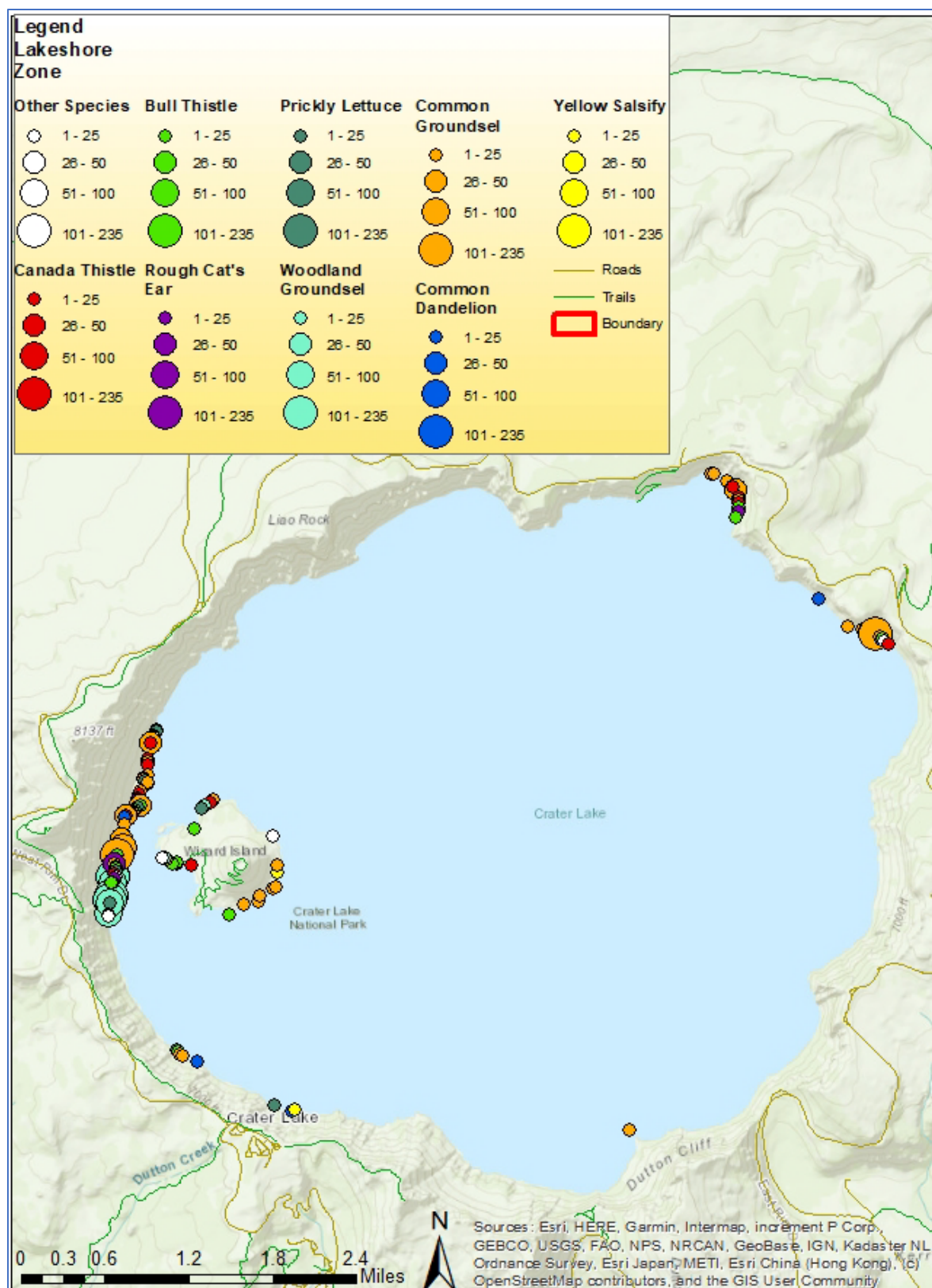


Figure 15. 2021 invasive plant populations in the Lakeshore Zone. Map by Alexandra von Bergman and Hamilton Hasty.

Roadside Zone

Park roads include Highway 62 (Figure 16), Munson Valley Road, West and East Rim Drives, Pinnacles Road, Grayback Road, North Entrance Road, and Highway 138. A high diversity and density of invasive plants in 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 2021, all roads within the Park were surveyed for invasive plant species. No invasive species were found or treated on Pinnacles Road and West Rim Drive in 2021, and Grayback Road (closed to public motor vehicle use) continues to remain free of invasive plant species. Twenty-two invasive plant species, totaling 13,927 individual plants, were treated along roadsides in 2021. Comparisons of roadside IVM regions surveyed and invasive plant species found during the 2017 to 2021 field seasons are listed in Tables 8 and 9. Roadside locations of invasive plant species encountered in 2021 are displayed in Figure 20.



Figure 16. The IVM crew surveys along Highway 62 while wearing appropriate safety gear. Photo by Alexandra von Bergman.

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 southern Park boundary, contains some of the largest and most abundant infestations of invasive plant species. Highway 138

(Figure 19), 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 along Munson Valley Road are concentrated near developed areas (Mazama Village, pullouts, and Park headquarters) where there is high visitor traffic.

The southernmost section of Highway 62 in the Panhandle region of the Park continues to sustain sizable populations of bulbous bluegrass (*Poa bulbosa*), with scattered small populations extending up to Munson Valley Road as well. Bulbous bluegrass reproduces through viviparous bulblets formed in the flowers; although some populations do not produce viviparous bulblets in the inflorescence. Bulbous bluegrass populations can contain both viviparous and seed-producing plants admixed (Meyers et al. 2015). This species is targeted for control in May as plants are starting to flower. The small plants are easily removed by hand-pulling, taking care to ensure all stem bulbs are dug up and removed from the site (Figure 17). Early control is important to prevent bulbous bluegrass from becoming a widespread invader at CRLA, as this species is a prolific weed in many western states (Scheinost et al. 2008).



Figure 17. An IVM crew member manually removes bulbous bluegrass from alongside Highway 62. Photo by Alexandra von Bergman.

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

Sheep sorrel, common dandelion, and St. John’s wort are early season targets for herbicide treatment along roadsides (Figure 18). Sheep sorrel and common dandelion have persistent roots (rhizomes and taproots, respectively) and are among the first species to flower and fruit, making early chemical treatment essential. Populations of St. John’s wort within Park boundaries continue to be well below the peak of over 18,000 plants in 2006. In 2021, 658 individual St. John’s wort plants were treated along roadsides, even as dense stands of St. John’s wort continue to line the highways and U.S. Forest Service roads just west of the Park.



Figure 18. An IVM crew member sprays sheep sorrel along Highway 62, while another crew member records data. Photo by River Allen.

Smooth brome remains persistent; however, this species has declined in abundance over recent years. This species can usually be found near Mazama Village, along Highway 62, and along Munson Valley Road. Twenty-eight individuals were treated in patches near the Annie Spring entrance station. Four individuals were found along West Highway 62 in the guardrails section. 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 usually the densest section that can easily escape detection.

Several populations of cheatgrass were discovered along Highway 62 south of the Park entrance and along Highway 138 in 2020. In 2021 only two cheatgrass individuals were found along Highway 138. This decline in numbers could be due to recent grading of the Highway 138 roadsides (Figure 18). Future surveys should continue to keep a close eye on these populations returning. Surveys along Highway 62 did not encounter any cheatgrass populations in 2021. Well-established and abundant populations of other non-native grasses, including Kentucky bluegrass (*Poa pratensis*), Canada bluegrass (*Poa compressa*), and colonial bentgrass (*Agrostis capillaris*), are only occasionally treated, and usually only when they threaten habitat for rare or sensitive plants or habitats, with the latter two species not being treated at all in 2021.

Common knotweed has drastically increased in abundance. It has been primarily found bordering lower Munson Valley Road and the Annie Creek Restaurant parking lot. It grows within cracks of the pavement making it difficult to manually remove. Herbicide treatments must be performed, but timing is limited by heavy visitor traffic in the summer months.

A newly discovered invasive plant species to the Park, dog-fennel, was found along west Highway 62 at the Corkscrews region. This species is a flowering annual in the Aster family with a noticeable and strong odor. Defining characteristics include outer white ray florets, central yellow disk florets, and branching upright stems. Plants form dense stands in disturbed areas and flower any time between spring and autumn. Desert alyssum (*Alyssum desertorum*), which was a newly discovered plant in 2019, was not found in 2021.



Figure 19. Highway 138 after being recently graded showing very few plants growing on the roadside. Photo by Alexandra von Bergman.

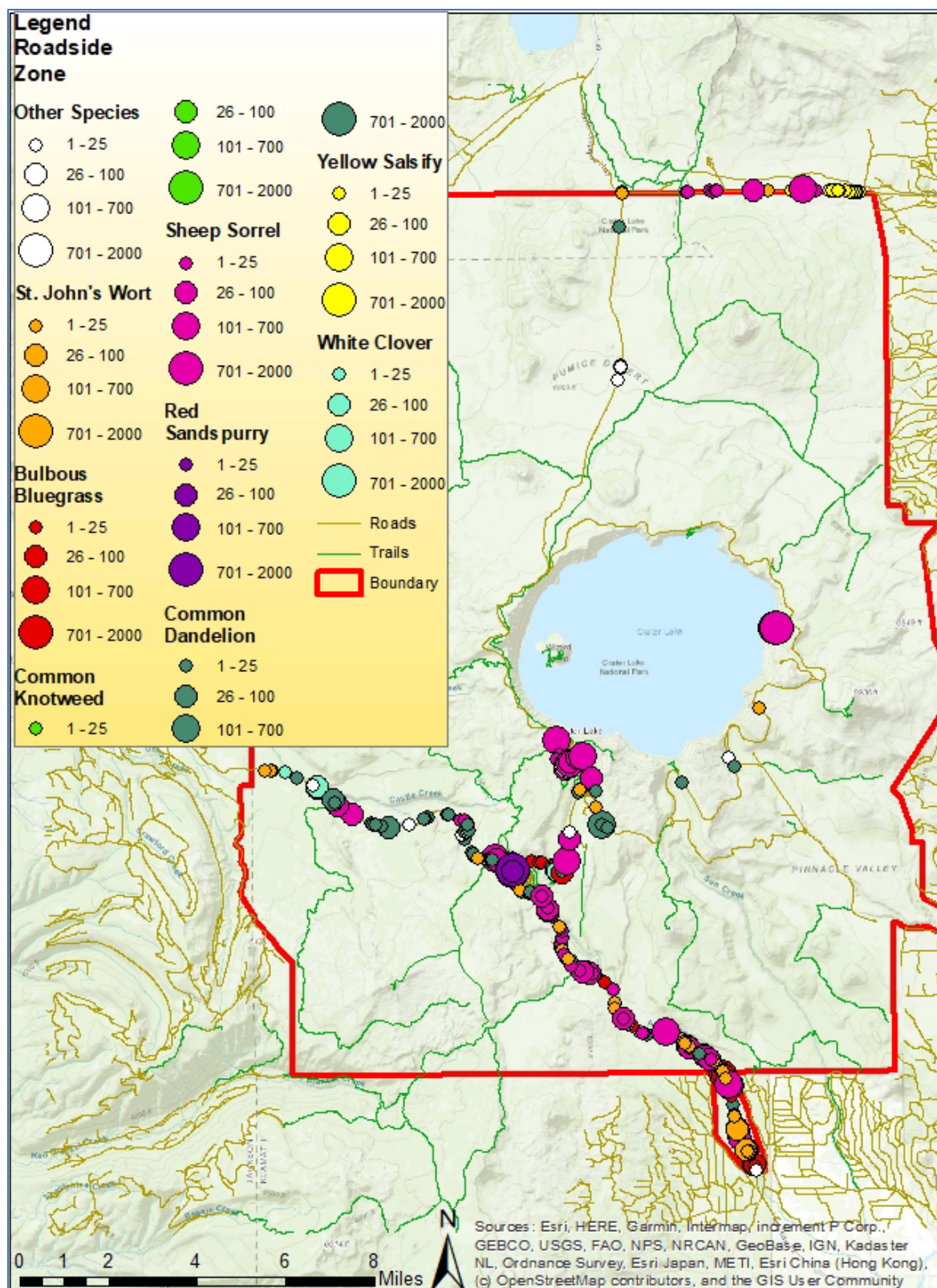
Table 8. Number of invasive plants treated in the Roadside Zone from 2017-2021 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Roadside Zone IVM Region	2021	2020	2019	2018	2017
East Rim Drive	4,339	327	883	170	5,665
Highway 138	417	852	3,793	4,260	9,373
Munson Valley Road	4,427	1,387	1,966	3,547	4,649
North Entrance Road	37	9	149	0	160
Pinnacles Road	0	0	0	*	56
South Highway 62	3,806	8,637	5,517	11,723	24,212
West Highway 62	905	958	2,063	1,042	9,530
West Rim Drive	0	0	37	1	*
Total	13,931	12,170	14,408	20,967	53,645

Table 9. Number of invasive plants treated in the Roadside Zone from 2017-2021 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2021	2020	2019	2018	2017
Colonial bentgrass (<i>Agrostis capillaris</i>)	*	*	421	10	*
Redtop (<i>Agrostis gigantea</i>)	*	*	*	15	31
Meadow foxtail (<i>Alopecurus pratensis</i>)	*	6	1	83	*
Desert Alyssum (<i>Alyssum desertorum</i>)	*	46	38	*	*
Dog-fennel (<i>Anthemis cotula</i>)	1	*	*	*	*
Tall oatgrass (<i>Arrhenatherum elatius</i> var. <i>elatius</i>)	*	*	*	1	5
Yellow rocket (<i>Barbarea vulgaris</i>)	5	2	4	2	48
Canola (<i>Brassica napus</i>)	*	2	*	*	*
Field mustard (<i>Brassica rapa</i>)	*	*	*	1	*
Smooth brome (<i>Bromus inermis</i>)	32	344	687	731	11,235
Cheatgrass (<i>Bromus tectorum</i>)	2	884	*	301	71
Diffuse knapweed (<i>Centaurea diffusa</i>)	1	*	*	*	*
Spotted knapweed (<i>Centaurea stoebe</i> ssp. <i>micranthos</i>)	7	*	21	12	33
Lamb's quarters (<i>Chenopodium album</i>)	*	*	*	3	*
Rush skeletonweed (<i>Chondrilla juncea</i>)	*	4	1	2	5
Chicory (<i>Cichorium intybus</i>)	*	*	1	*	1
Canada thistle (<i>Cirsium arvensis</i>)	*	*	1	1	2
Bull thistle (<i>Cirsium vulgare</i>)	*	*	2	*	3
Field bindweed (<i>Convolvulus arvensis</i>)	*	4	3	9	15
Wild carrot (<i>Daucus carota</i>)	*	*	*	*	1

Plant Species	2021	2020	2019	2018	2017
Tall orchardgrass (<i>Dactylis glomerata</i>)	*	*	10	*	*
Jerusalem oak (<i>Dysphania botrys</i>)	*	*	47	*	94
Quackgrass (<i>Elymus repens</i>)	*	*	422	*	*
Red fescue (<i>Festuca rubra</i>)	*	*	50	*	*
St. John's wort (<i>Hypericum perforatum</i>)	659	547	592	298	1,572
Hairy cat's ear (<i>Hypochaeris radicata</i>)	*	2	1	1	9
Dyer's woad (<i>Isatis tinctoria</i>)	*	*	*	*	31
Prickly lettuce (<i>Lactuca serriola</i>)	*	*	3	*	*
Field pepperweed (<i>Lepidium campestre</i>)	*	*	*	16	*
Purple anther field pepperweed (<i>Lepidium heterophyllum</i>)	2	*	237	197	410
Oxeye daisy (<i>Leucanthemum vulgare</i>)	3	7	*	7	10
Pineapple weed (<i>Matricaria discoidea</i>)	*	*	*	*	60
Reed canarygrass (<i>Phalaris arundinacea</i>)	*	*	*	12	*
Timothy (<i>Phleum pratense</i>)	3	*	9	15	102
English plantain (<i>Plantago lanceolata</i>)	16	1	32	3	*
Common plantain (<i>Plantago major</i>)	2	*	*	1	31
Annual bluegrass (<i>Poa annua</i>)	*	100	*	*	40
Bulbous bluegrass (<i>Poa bulbosa</i>)	1,669	4,275	2,616	6,423	9,251
Canada bluegrass (<i>Poa compressa</i>)	*	*	320	267	*
Kentucky bluegrass (<i>Poa pratensis</i>)	16	38	*	1,788	18
Common knotweed (<i>Polygonum aviculare</i> ssp. <i>depressum</i>)	1,009	*	3	*	296
Sheep sorrel (<i>Rumex acetosella</i>)	7,749	4,676	6,464	6,954	23,779
Tansy ragwort (<i>Senecio jacobaea</i>)	*	*	*	*	67
Woodland groundsel (<i>Senecio sylvaticus</i>)	*	1	*	5	*
Common groundsel (<i>Senecio vulgaris</i>)	1	*	*	*	*
Tall Fescue (<i>Schendonorus arundinaceus</i>)	*	*	38	*	*
Red sand-spurrey (<i>Spergularia rubra</i>)	1,100	*	10	28	*
Common tansy (<i>Tanacetum vulgare</i>)	*	*	*	1	*
Dandelion (<i>Taraxacum officinale</i>)	1,445	1,142	2,240	3,358	4,695
Pubescent wheatgrass (<i>Thinopyrum intermedium</i>)	*	*	*	75	*
Yellow salsify (<i>Tragopogon dubius</i>)	72	82	74	99	50
Red clover (<i>Trifolium pratense</i>)	1	*	*	*	1
White clover (<i>Trifolium repens</i>)	133	*	54	30	1,642
Cowboy toilet paper (<i>Verbascum thapsus</i>)	3	7	6	3	37



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 plants as possible (Figure 21). Staging area invasive plant locations encountered in 2021 are displayed in Figure 22. Comparisons with findings from the 2017 to 2021 field seasons are made in Tables 10 and 11.



Figure 21. An IVM crew member surveys the South Yard for invasive plant species. Photo by Carrie Wyler.

In 2021, invasive plants were treated at four of the six staging areas: Anderson Quarry, Pole Bridge Creek Quarry, South Yard, and the Ball Diamond. A total of 363 invasive plants were treated from seven invasive plant species: yellow rocket, yellow salsify, rough cat's ear, cowboy toilet paper, red sand-spurrey, common dandelion, and new-to-CRLA invasive plant species hairy bittercress found at the Ball Diamond. No invasive plants were found at the Watchman Quarry or Roundtop Quarry.

Red sand-spurrey was the most abundant invasive plant species encountered in these areas. Populations have increased in size since the 2020 field season. 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 in 2020, but was not found again in 2021. Hairy bittercress was discovered at the Ball Diamond near the nursery for the first time. It is assumed to have entered the Park on containerized plants received from a partner nursery. Any plant

shipments received from outside of the Park need to be thoroughly checked for hitchhiking invasive plant species.

Table 10. Number of invasive plants treated in the Staging Area Zone from 2017-2021 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Staging Area Zone IVM Region	2021	2020	2019	2018	2017
Anderson Quarry	1	0	7	47	1
Ball Diamond	340	50	*	0	1,420
Pole Bridge Creek Quarry	14	45	100	9	31
Roundtop Quarry	0	0	0	0	0
South Yard	8	5	52	5	74
Watchman Quarry	0	0	0	0	0
Total	363	100	159	61	1,526

Table 11. Number of invasive plants treated in the Staging Area Zone from 2017-2021 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2021	2020	2019	2018	2017
Yellow rocket (<i>Barbarea vulgaris</i>)	2	4	107	9	11
Smooth brome (<i>Bromus inermis</i>)	*	*	*	*	5
Hairy bittercress (<i>Cardamine hirsuta</i>)	35	*	*	*	*
Bull thistle (<i>Cirsium vulgare</i>)	*	*	*	1	4
Yellow sweetclover (<i>Melilotus officinalis</i>)	*	*	45	*	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	*	*	*	*	1
Sulfur cinquefoil (<i>Potentilla recta</i>)	*	20	*	*	*
St. John's wort (<i>Hypericum perforatum</i>)	*	8	*	*	*
Rough cat's ear (<i>Hypochaeris radicata</i>)	1	*	*	*	*
Red sand-spurrey (<i>Spergularia rubra</i>)	304	50	*	*	1,432
Common dandelion (<i>Taraxacum officinale</i>)	13	13	*	*	9
Yellow salsify (<i>Tragopogon dubius</i>)	5	1	6	2	31
Cowboy toilet paper (<i>Verbascum thapsus</i>)	3	4	1	2	33

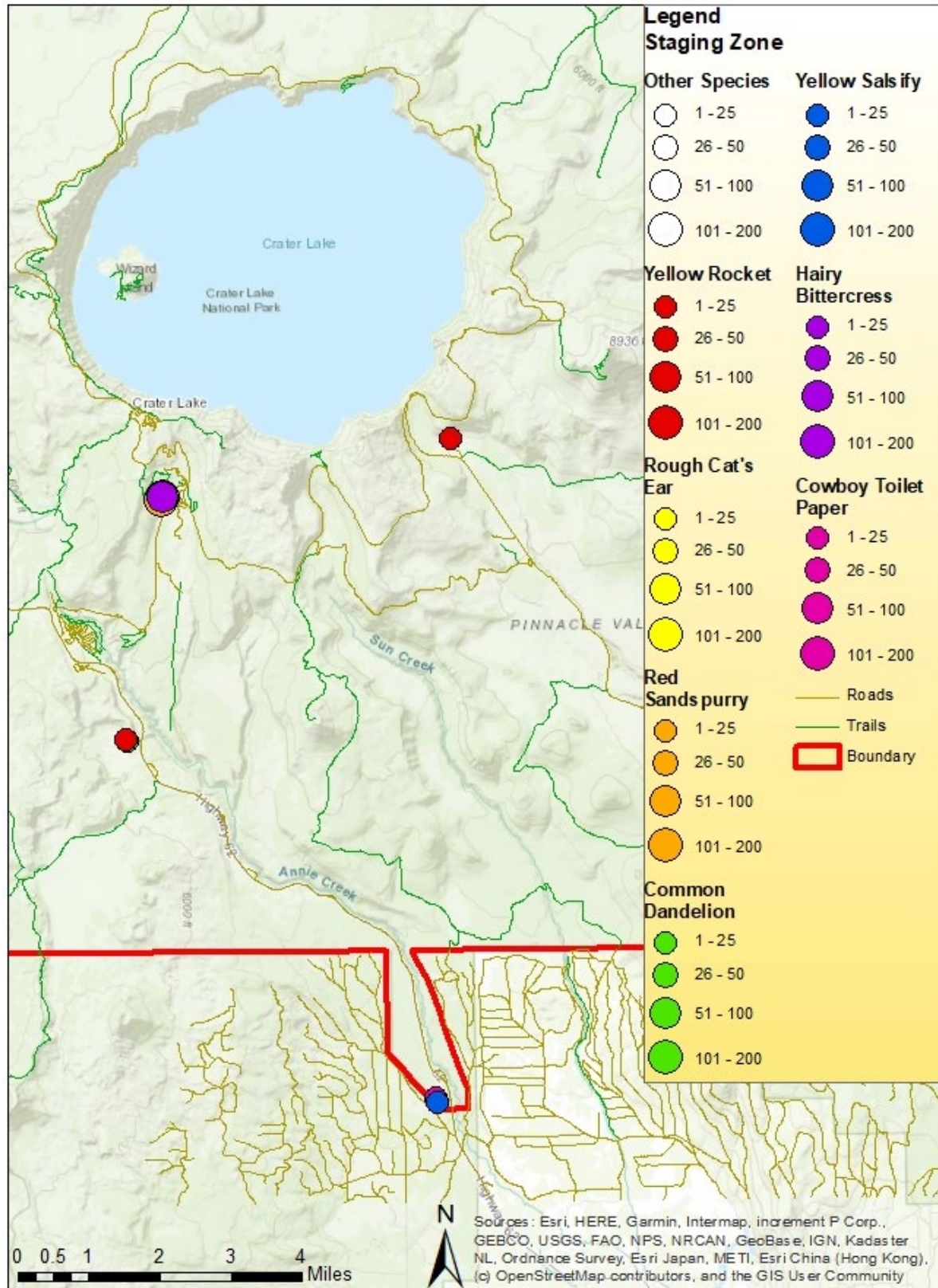


Figure 22. 2021 invasive plant populations in the Staging Areas Zone. Map by Alexandra von Bergman and Hamilton Hasty.

Discussion

In 2021 there were no invasive plants found along West Rim Drive associated with Phase I of the Rim Drive Rehabilitation project. As the Rim Drive Rehabilitation project progresses it will become increasingly important to continue monitoring for invasive species along West and East Rim Drives especially as efforts continue to revegetate those areas. Another project being carried out in 2021 was the Alternative Fuels Management work along south Highway 62, Mazama Village, and Munson Valley. Surveys in following years should focus on the areas where pile burning will occur to prevent any invasive species from becoming established in those recently disturbed areas. Highway 138 experienced roadside grading in 2020 and 2021 by the Oregon Department of Transportation, which completely displaced vegetation within this corridor. This resulted in invasive plant surveys in spring and early summer yielding few invasive plant species. Cheatgrass was found in low numbers this year, but all historic population sites should be checked again next season.

The 2021 field season was greatly impacted by fires in the surrounding area causing poor air quality conditions for many weeks. These conditions caused the backcountry camping trip at the Blanket Creek Fire to end earlier than planned. The large infestation of cowboy toilet paper on the eastern edge of this fire will need attention in future years, ideally during a backcountry camping trip as the site is time consuming to access. A larger crew would also be ideal to tackle this population if possible.

The Crater Creek wall lettuce population responded well to herbicide treatment in 2020; if time allows, another treatment should be conducted in the future. The wall lettuce at this site could become manageable over time with consistent herbicide treatments; manual removal will not be enough to eradicate the species. Wall lettuce populations in the National Creek Complex will need be followed up on with herbicide treatment; there was not enough time this year to fully treat them. The National Creek Complex will need continual surveys in future years because various new invasive plant populations were discovered this 2021 season. Additionally, sheep sorrel patches at Poison Meadows and Annie Creek will need to be kept up with in future seasons to ensure they do not get out of control.

The lakeshore wood groundsel populations will need continual control to prevent the populations from expanding. As much time as possible, and with as many crew members as possible, should be spent at the “Discovery Point to Merriam Point” section of the lakeshore as that area had the highest concentration of invasive plants. Due to rainy conditions during the lakeshore week this year that precluded the ability to use herbicide, follow up herbicide treatment will be especially important for this section of the lakeshore next season.

Along roadsides and especially in developed areas, common knotweed needs to be a high priority. Populations appear to have dramatically increased and small plants grow out of cracks in the pavement which makes them hard to find. Due to this, it is possible plants were overlooked in previous seasons causing the populations to explode. Special care to look in all crevices will be necessary to control common knotweed and keep population numbers down. The alternative possible explanation to the increase in common knotweed individuals is the plant is resilient to our

herbicides or herbicide concentrations. It may be advisable to more extensively research control methods for common knotweed in the future. Since numbers are still low enough to be able to control it, the knotweed should take priority over red sand-spurrey in these areas.

A new sheep sorrel patch was discovered this season on East Rim Drive in a meadow near Skell Head which significantly raised the number of invasive plants controlled in this area from previous years. This patch should continue be a high priority next season to keep it under control.

Lastly, hairy bittercress is assumed to have been introduced within the Ball Diamond on containerized plants received from a partner nursery. Careful weeding of nursery pots and ensuring these weeds are not composted on-site will be necessary for all future nursery plants imported into the Park.

Additional recommendations for IVM work in 2022 include:

- 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 sheep sorrel and St. John's wort.
- Crater Creek experienced a significant increase in wall lettuce in 2020. Efforts should be made to check 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 identify specimens.
- Perform bi-weekly data quality control checks when the data are uploaded, and herbicide record forms are updated.
- If able, plan backcountry camping trips early in the season to ensure administrative staff can establish travel-related accounts in time.
- Continue to survey for and manually treat desert alyssum at the Ponderosa Pine Picnic Area in early May.
- Continue to walk West and East Rim Drives to survey for invasive plant establishment.
- Field data collection will need to move to Field Maps from Collector. When building the 2022 IVM project, ensure that spatial layers of all treatment avoidance areas are loaded as reference layers to ensure no treatment occurs within exclusion zones.

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April 2022

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