



Invasive Vegetation Management

2017 Annual Report



**ON THIS PAGE**

The Invasive Vegetation Management Crew surveys for invasive plants along Highway 62.
Photo by Sarah Hall.

ON THE COVER

The Invasive Vegetation Management Crew hikes into the National Creek Complex burned area.
Photo by Delacey Randall.

Invasive Vegetation Management

2017 Annual Report

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This annual report series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by a subject matter expert who was not directly involved in the collection, analysis, or reporting of the data.

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

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Abstract

Work performed by the 2017 Crater Lake National Park Invasive Vegetation Management program continued a 15-year effort to detect, contain, and reduce invasive plant species within the Park. A major accomplishment was the implementation of the Park's new Invasive Vegetation Management Plan. Using manual and chemical methods an estimated 160,116 invasive plants were treated in 2017. One new-to-the-Park invasive plant species (wild carrot – *Daucus carota*) was discovered along a Park roadside. Large construction projects and two large wildfires occurring within the Park this season presented challenges to the Invasive Vegetation Management program. Wildfires prevented invasive plant survey and control efforts on the western half of the Park for the majority of the 2017 field season; the areas subject to fire closures should be high priorities for 2018 work. The Rim Drive Rehabilitation and Pacific Crest Trailhead well construction projects continued to cause much ground disturbance and increase potential for invasive plant introductions.

Acknowledgments

The 2017 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 Federal Highways Administration – Western Federal Lands Highway Division, and the National Park Service Recreation Fee program. The Crater Lake National Park Revegetation crew provided assistance with invasive plant survey and control efforts, especially Melody Frederic, Scott Heisler, and Tara Chizinski. Invasive plant observations reported by other Crater Lake National Park employees, especially the Bull Trout and Roads staffs, were greatly appreciated and very helpful in preventing the spread of invasive plants. Chris Wayne supported data collection efforts through maintenance of a geodatabase and Trimble Juno units.

Introduction

The 2017 field season marked the fifteenth year of recurring management (Figure 1) 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.

Anecdotal evidence suggests that Crater Lake National Park (CRLA) is relatively pristine compared to other National Park Service (NPS) units. Due to its high elevation position spanning the Cascade crest, its abundant snowfall, and its limited disturbance history (excluding the large fires of the last three years), CRLA has been better protected against invasion by non-native plant species than other NPS units. The IVM program at CRLA is tasked with upholding and improving this unique status.

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.



Figure 1. IVM crew member treating St. John's wort with herbicide near Park headquarters. Photo by Sarah Hall.

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

The 2017 IVM field season was notable for a few reasons. The crew consisted of seven members, which was tied with 2016 for the largest crew size in the history of the program. In 2017, the IVM program implemented a new Invasive Vegetation Management Plan (USDI NPS 2017), which included chemical treatment methods that allowed for rapid and effective treatment of previously time consuming and difficult-to-control plant species.

A number of natural (and some unnatural) events occurred during the summer of 2017 that impacted the activities of the IVM crew. After four consecutive years of below-average snowfall, CRLA received 592 inches of snow from October 1, 2016 to September 30, 2017 (the average is 524 inches), which is 115% of average. The first snow-free day at Park Headquarters was July 5th, compared to June 8th in 2016 and May 11th in 2015 (average date is June 20th). This late snowmelt date shortened the field season which compressed the workload into an already small survey and treatment window. In May, the Park had its municipal water supply turned off. Construction crews installed a new well at the Pacific Crest Trail parking area and installed a new waterline along Highway 62 connecting the well to the existing water tanks, resulting in significant roadside and interior disturbance. Two large fires, the Blanket Creek and Spruce Lake (Figure 2) fires, started on July 25 and 29, respectively, and continued to burn until extinguished by October snowfall. The fires restricted access to the west side of the Park, limiting IVM activities, and the smoke associated with these and other fires in the region drastically reduced air quality and occasionally forced cessation of field work.



Figure 2. The Spruce Lake fire heading towards the Watchman Lookout on August 4, 2017. Photo by Michael Hernandez.

The majority of weeds in CRLA are found along roadsides and in developed areas. This was exacerbated by a Pavement Preservation project in 2014 that placed contaminated (i.e., weed-containing) gravel on most Park roads (Highway 62, Munson Valley Road, headquarters/housing service roads, Pinnacles Road, Cloudcap Road, and the North Entrance Road). The Pavement Preservation project also utilized numerous areas for temporary storage of base rock and other earthen materials, including the Pumice Desert Overlook, South Yard, the Ballfield, junction of East Rim Drive with Pinnacles Road, Pole Bridge Creek quarry, and the junction of the North Entrance Road with West Rim Drive. The IVM program received three years of funding from Federal Highways Administration in order to survey and treat the affected areas. Funding was also 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 2014 Pumice Complex of fires, the 2015 National Creek Complex (Figure 3), and the 2016 Bybee Creek fire. Areas targeted for invasive plant survey and control efforts included firelines, aerial fire retardant application zones, spike camps, and helispots. Another funding source for the 2017 IVM program was the NPS Recreation Fee Program, which funded survey and treatment of invasive plant species within high visitor-use areas. This improved and enhanced the visitor experience through protecting native plant communities, including highly scenic wildflower displays, and maintaining the scenic beauty of the Park for enjoyment by future generations of Park visitors.



Figure 3. IVM crew members surveying for invasive plants in an area burned by the Crescent fire of the 2015 National Creek Complex. Photo by Eddie Silahua.

Methods

Crater Lake has been divided into five IVM Zones (Backcountry, Developed Area, Lakeshore, Roadside, and Staging Area) 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 biological 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 pristine wilderness environment 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 4. The IVM crew searches for invasive plants using a grid formation. Photo by Lindsay Crouch.

Vegetation surveys consist of visually searching a region for invasive plants, 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 (Figure 4) 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 (m²), and treatment applied to the population. Data are input into a Trimble Juno field computer and GPS receiver using ArcPad software. Plants are either pulled from the soil intact using Hori-Hori digging knives, or sprayed with herbicide via a backpack (Figure 5) 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 weed 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

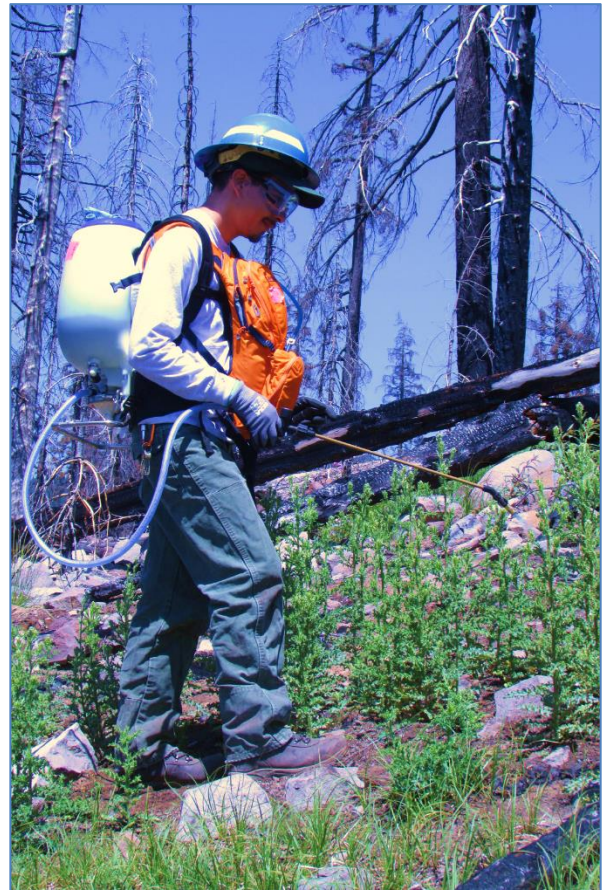


Figure 5. Canada thistle plants being sprayed with herbicide in the 2015 National Creek Complex area. Photo by Sarah Hall.

collection are placed in a specimen refrigerator for preservation. Once the plant is identified, the plant species name is changed from 'Unknown' to the correct species code in ArcPad or the IVM database.

The 2017 field season marked the implementation of a more comprehensive treatment program at CRLA. After the Invasive Vegetation Management Plan Environmental Assessment was approved in mid-July, the IVM crew started using herbicide as a treatment option. Ten herbicides were approved for use in the Park, with four herbicides submitted and approved for use through the NPS Pesticide Use Permitting System (PUPS) in 2017 (Table 1). Three herbicides were used in 2017: Roundup ProMax, Roundup Custom (for areas near water), and Milestone.

Table 1. Herbicides approved for use under the CRLA Invasive Vegetation Management Plan Environmental Assessment. Bold type indicates herbicides approved for use in 2017 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	Arsenal, Habitat, Stalker	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. Secure storage facilities were established 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 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 (Figure 6). The crew utilized both backpack and hand sprayers. Backpack sprayers are more traditionally used for herbicide application; however, CRLA contains very few invasive plant monocultures, thus hand sprayers generally have sufficient capacity. Hand sprayers have the advantage of being far more portable than backpack sprayers, and allow the applicator to carry a normal backpack while working.

When leaving the vehicle and gearing up for the field, hand sprayers may be 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.



Figure 6. IVM crew members measure herbicide concentrate during the mixing and loading process. Photo by Sarah Hall.

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 may be collected as they can 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, and early in the morning when leaves are covered in dew.

Data collection for herbicide treatment is almost identical to data entry when treating with manual methods. However, upon return to the vehicle or office, 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 number of all

applicators. The ODA data are recorded and later transcribed 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 22 – October 31, 2017. Approximately 160,116 invasive plants were controlled during the 2017 field season, including one non-native plant species that had not been previously recorded within CRLA: wild carrot (*Daucus carota*) that was found along a Park roadside. This brings the number of non-native plant species documented within CRLA to 86. Control efforts put forth by the 2017 IVM program are presented by general zones. Data displayed on the following maps indicate the number of invasive plants found and treated during the 2017 season.

Backcountry Zone

The Park's backcountry zone includes any areas away from roads, developed areas, staging areas, and the Crater Lake shoreline. A total of 51,024 invasive plants were treated in the Park's backcountry areas during the 2017 field season (Figure 9; Tables 2 and 3). Much of the western half of the Park has burned over the past three years. 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 does the east side.

Most of the western part of the Park was closed during August and September due to the Spruce Lake and Blanket Creek fires. This unfortunately hampered the crew's ability to survey previously burned areas (Figure 7). Due to the proximity of the Blanket Creek fire, both the upper and lower portions of the Red Blanket area were only surveyed once and twice, respectively, and were only visited before herbicide use was approved. A total of 2,809 individual plants comprised of seven plant species were treated; the majority of the plants treated were bull thistle (*Cirsium vulgare*).



Figure 7. Treating invasive plants with herbicide in the 2016 Bybee fire (left – photo by Sarah Hall); and manually within the 2015 National Creek Complex (right – photo by Katie Ripstein).

There were a total of 2,547 plants and 10 plant species treated within the 2015 National Creek Complex this year. The number of plants treated nearly doubled from last year even with this area being off limits during most of the season. The majority of plants (2,516) were found within the boundary of the Border fire that overlapped with the National Creek Complex and took place in 2001. This illustrates the importance of surveying recently burned areas multiple times as they seem to harbor more invasive plants. Also of note is the discovery of Canada thistle, bull thistle, and

dandelion populations within the boundary of the Desert Ridge fire that took place in 2009. This area is located just south of areas burned during the 2015 National Creek Complex, and was previously believed to be weed-free.

The 2016 Bybee fire was surveyed for the first time on two separate occasions. This fire is within the boundary of the 2006 Bybee fire making it more susceptible to invasive plant infestations. Like many of the other areas the IVM crew surveys, this area was closed during prime survey and treatment times due to the fires in the Park. In just two visits the crew was able to treat 699 plants consisting of seven plant species. Of mention was one population of sheep sorrel (*Rumex acetosella*) consisting of 600 plants. All invasive plant populations were found near or in riparian areas.

The Castle Creek fire of 2008 was visited only once this year after area closures were lifted in October. Approximately 1,150 plants were treated, consisting mostly of bull thistle. Thousands of bull thistle plants were already senesced and subsequently were not treated. This site should be surveyed multiple times next season.

The Upper Panhandle prescribed burn and Baboon fire areas were surveyed this year. It was determined that in previous years invasive plants were mapped as being in the Baboon fire (1994) when in actuality they were located within the boundary of the Upper Panhandle burn (2010), which partially overlaps the Baboon fire perimeter. For simplicity, it was decided to combine these two burns into one treatment area (Upper Panhandle Burn) in the IVM database. Despite the overlap of these burns only 23 of the 1,519 plants treated this year were found to be in the area affected by the Baboon fire alone. The plants treated consisted of five plant species, the majority being bull thistle and prickly lettuce (*Lactuca serriola*).

Wetlands, meadows, and riparian corridors (Figure 8) are some of the most biologically diverse and delicate systems in the Park making the control of invasive plant species important and often times more challenging. Even though no herbicide application occurs to submerged vegetation or over water, considerations need to be taken for wildlife species that occupy aquatic habitats and the interface of aquatic and terrestrial environs. Roundup Custom, which is approved for use in aquatic systems, was used for treatment of all invasive plant species within riparian corridors, meadows, wetlands, and ephemerally moist areas.



Figure 8. An IVM crew member documents an invasive plant occurrence on a Trimble Juno GPS unit near Sun Creek. Photo by Sarah Hall.

Meadow and wetland systems surveyed in 2017 include Poison Meadows, Thousand Springs, Sphagnum Bog, National Creek meadows, Spruce Lake, the Panhandle's Cottonwood meadows, and Castle Creek Meadows. No invasive plants were detected at Sphagnum Bog, which is heartening

since this is a Research Natural Area containing high levels of biodiversity and rare plants. No invasive plants were found at Spruce Lake due to unusually high water levels. The increased treatment numbers shown for Poison Meadows are due to a few causes: a larger crew allowed for more effective gridding in such a large meadow system; numerous trips to the site expanded surveys into more meadows in the area; and weather allowed for more site visits later in the season.

Riparian areas within the Park that have historically been surveyed include Annie Creek, Bybee Creek, Castle Creek, Crater Creek, Pothole Creek, Sand Creek, and Sun Creek. In 2016, a large sheep sorrel population was found near Annie Creek and went untreated. During the 2017 field season several more populations were found and treated, demonstrating that the invasion found in 2016 is now an established population in Annie Creek.

Table 2. Number of invasive plants treated in the Backcountry Zone from 2015—2017 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Backcountry Zone IVM Region	2017	2016	2015
Annie Creek	4,025	3,718	5,923
Bybee Creek - Lower	699	*	44
Castle Creek - Lower	1,655	972	1,373
Castle Creek - North Fork	180	261	584
Castle Crest Wildflower Garden	12	*	1
Castle Fire	1,155	1,442	5,189
Cornerstone Burn Unit	0	*	*
Crater Creek - Lower	759	*	3,083
Desert Ridge	365	*	*
National Creek	2,738	2,000	*
National Creek Complex	2,547	1,084	*
Panhandle - Interior	*	205	324
Panhandle - Cottonwood Meadow	2,255	469	1,591
Poison Meadows	17,187	6,362	4,766
Pothole Creek	391	46	500
Pumice Complex	*	6	0
Red Blanket Canyon	2,809	8,965	16,448
Sand Creek	*	*	386
Spruce Lake	0	249	2,276
Sun Creek	8,942	2,702	2,457
Thousand Springs	3,800	3	*
Upper Panhandle Burn Unit/Baboon	1,519	1,116	16,467
Total	51,024	29,600	61,411

Table 3. Number of invasive plants treated in the Backcountry Zone from 2015—2017 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2017	2016	2015
Cheat grass (<i>Bromus tectorum</i>)	*	105	161
Canada thistle (<i>Cirsium arvensis</i>)	4,091	2,942	757
Bull thistle (<i>Cirsium vulgare</i>)	7,554	13,166	34,899
Field bindweed (<i>Convolvulus arvensis</i>)	*	50	900
Tall orchardgrass (<i>Dactylis glomerata</i>)	*	1	*
Jerusalem oak (<i>Dysphania botrys</i>)	20	*	*
St. John's wort (<i>Hypericum perforatum</i>)	54	592	701
Dyer's woad (<i>Isatis tinctoria</i>)	74	*	*
Hairy cat's ear (<i>Hypochaeris radicata</i>)	*	*	4
Tall lettuce (<i>Lactuca canadensis</i>)	822	1	591
Prickly lettuce (<i>Lactuca serriola</i>)	229	401	1,124
Reed canarygrass (<i>Phalaris arundinacea</i>)	1,090	865	300
Timothy (<i>Phleum pratense</i>)	2,580	16	50
Annual bluegrass (<i>Poa annua</i>)	10	94	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	*	*	55
Sheep sorrel (<i>Rumex acetosella</i>)	8,999	2,820	*
Curly dock (<i>Rumex crispus</i>)	*	*	72
Tansy ragwort (<i>Senecio jacobaea</i>)	10	9	*
Woodland groundsel (<i>Senecio sylvaticus</i>)	43	304	7,331
Prickly sow thistle (<i>Sonchus asper</i>)	1	*	39
Dandelion (<i>Taraxacum officinale</i>)	17,565	3,323	3,779
Yellow salsify (<i>Tragopogon dubius</i>)	7,558	4,311	5,274
White clover (<i>Trifolium repens</i>)	235	112	*
Mullein (<i>Verbascum thapsus</i>)	89	387	5,366

Two invasive plant species were encountered in the Park's backcountry for the first time this year: dyer's woad (*Isatis tinctoria*) and Jerusalem oak (*Dysphania botrys*). The majority of the dyer's woad plants were found at Poison Meadows; some dyer's woad along with Jerusalem oak were discovered in the Annie Creek area. The Park's only known backcountry cheat grass (*Bromus tectorum*) infestation was unable to be treated this year due to wildland fire area closures. This site is located in the lower Red Blanket Canyon, and is difficult to access due to unpredictable road access and steep, rugged slopes.

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 the 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 (Figure 10). In 2017, 56,214 invasive plants were controlled (Figure 11). Comparisons with findings from the 2015 and 2016 field seasons are made in Tables 4 and 5.



Figure 10. Dyer's woad established in a landscaping bed at Mazama Village. Photo by Jen Hooke.

Across all developed areas, sheep sorrel and red sandspurry were the most abundantly encountered invasive plant species. Of the 18 other species, only broadleaf cottonrose (*Filago pyramidata* var. *pyramidata*), pineapple weed (*Matricaria discoidea*), yellow rocket, dandelion, and white clover (*Trifolium repens*) had more than 200 individuals.

The overwhelming majority of invasive plants in the Park's developed areas were found at Rim Village, with Park headquarters/housing containing significant infestations as well. No invasive plants were found at either campground. There were more weeds treated in 2017, but relative abundances overall and per site are similar to data collected from 2015-2016 (Table 4). It should be noted that red sandspurry is not a high priority weed for treatment Park-wide due to its abundance, but it infests restoration areas and inhibits the recovery of native plant species so is treated when time allows in these areas.

Table 4. Number of invasive plants treated in the Developed Zone from 2015—2017 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Developed Zone IVM Region	2017	2016	2015
Headquarters/Housing	8,520	18,815	16,181
Lost Creek Campground	0	45	7
Mazama Campground	0	56	*
Mazama Dorms	1,048	4	*
Mazama Village	594	2,926	36
Rim Village	46,052	27,496	30,630
Total	56,214	49,342	46,854

Table 5. Number of invasive plants treated in the Developed Zone from 2015—2017 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2017	2016	2015
Yellow rocket (<i>Barbarea vulgaris</i>)	675	554	456
Smooth brome (<i>Bromus inermis</i>)	30	2,628	*
Canada thistle (<i>Cirsium arvensis</i>)	10	*	*
Bull thistle (<i>Cirsium vulgare</i>)	1	2	*
Tall orchardgrass (<i>Dactylis glomerata</i>)	12	*	*
Broadleaf cottonrose (<i>Filago pyramidata</i> var. <i>pyramidata</i>)	1,025	135	500
Hairy cat's ear (<i>Hypochaeris radicata</i>)	*	*	1
St. John's wort (<i>Hypericum perforatum</i>)	11	125	16
Field pepperweed (<i>Lepidium campestre</i>)	*	*	15
Birdsfoot trefoil (<i>Lotus corniculatus</i>)	1	*	2
Pineapple weed (<i>Matricaria discoidea</i>)	729	635	73
Yellow sweet clover (<i>Melilotus officinalis</i>)	1	*	*
Timothy (<i>Phleum pratense</i>)	*	*	20
English plantain (<i>Plantago lanceolata</i>)	3	*	*
Common plantain (<i>Plantago major</i>)	27	5	87
Annual bluegrass (<i>Poa annua</i>)	140	7	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	1	*	*
Canada bluegrass (<i>Poa compressa</i>)	*	*	350
Common knotweed (<i>Polygonum aviculare</i> ssp. <i>depressum</i>)	1,019	*	*
Sheep sorrel (<i>Rumex acetosella</i>)	26,528	15,846	5,408
Curly dock (<i>Rumex crispus</i>)	25	*	6
Red sandspurry (<i>Spergularia rubra</i>)	24,717	25,046	38,542
Dandelion (<i>Taraxacum officinale</i>)	713	2,857	834
Yellow salsify (<i>Tragopogon dubius</i>)	*	*	5
Scentless mayweed (<i>Tripleurospermum inodorum</i>)	*	*	3
White clover (<i>Trifolium repens</i>)	545	1,333	533
Mullein (<i>Verbascum thapsus</i>)	1	2	2

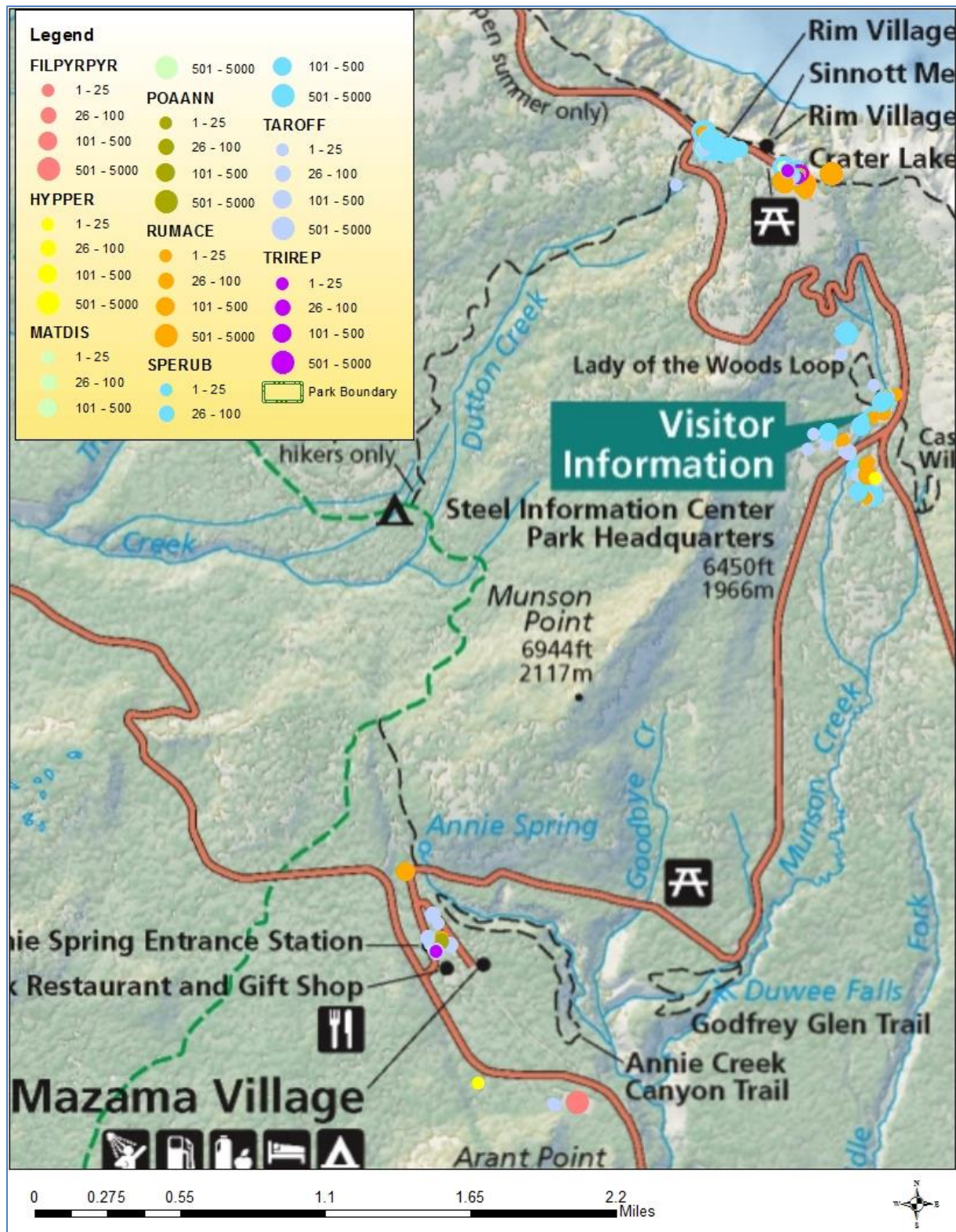


Figure 11. 2017 invasive plant populations in the Developed Area Zone. FILPYRPHYR = broadleaf cottonrose; HYPPER = St. John's wort; MATDIS = pineapple weed; POAANN = annual bluegrass; RUMACE = sheep sorrel; SPERUB = red sandspurry; TAROFF = dandelion; TRIREP = white clover. Map by Jen Hooke.

Lakeshore Zone

The shore of Crater Lake contains several invasive plant species; the most difficult to control are Canada thistle, St. John's wort, and sheep sorrel (Figure 13). These three species are perennial and rhizomatous; in sandy soils it has been possible to extract the entire root mass of some plants, and a reduction in population size has been achieved in past years. In other areas with rocky or harder substrates, manual treatment methods have been less effective especially since plants can sprout from tiny root fragments left behind in the soil. This year invasive plant populations were treated with herbicide for the first time, which proved to be a much more effective method in rocky areas than manual removal. Invasive plant populations encountered along the lakeshore are displayed in Figure 14. Comparisons with findings from the 2015 and 2016 field seasons are made in Tables 6 and 7.

An herbicide approved for use in aquatic habitats, Roundup Custom, was used along the lakeshore (Figure 12). The crew used hand sprayers and transported them in dry bags to reduce the possibility of spillage. While surveying the hand sprayers were kept in dry bags (that were either attached to or in a backpack) and taken out when invasive plants were found. This was found to be the easiest and safest way to carry herbicide along the rocky and uneven terrain of the lakeshore.



Figure 12. An IVM crew member treats Canada thistle with herbicide on the shores of Crater Lake. Photo by Sarah Hall.

The IVM Crew was able to survey the lakeshore on four different occasions this season: two days at the beginning of August and two days at the beginning of September. Survey days were spread over time to account for differing phenologies of plant species. Due to some boat mechanical issues the IVM crew was not able to survey from the boat or be shuttled to smaller plant populations with difficult access. Survey and treatment efforts were focused on areas that were walkable for long distances: the Watchman Bench, below

Wineglass, and Wizard Island. Because of the above-average snow pack this year many of the historic weed populations were under water or snow at the time of survey.

A total of 253 plants and six species were treated on the lakeshore this year (Tables 6-7). A new species to the lakeshore, Jerusalem oak, was found in two different locations: Wizard Island and the stretch of lakeshore between Discovery Point and Merriam Point. As a high priority weed, it will be important to keep an eye out for this species in the future. Fortunately only one plant was found at each location, making eradication a possibility.

Table 6. Number of invasive plants treated in the Lakeshore Zone from 2015—2017 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Lakeshore Zone IVM Region	2017	2016	2015
Cleetwood Cove to Skell Head	225	127	147
Skell Head to Eagle Point	*	0	*
Eagle Point to Discovery Point	0	338	*
Discovery Point to Merriam Point	15	203	173
Merriam Point to Cleetwood Cove	*	*	*
Wizard Island	13	5	122
Total	253	606	442

Table 7. Number of invasive plants treated in the Lakeshore Zone from 2015—2017 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2017	2016	2015
Canada thistle (<i>Cirsium arvensis</i>)	30	126	99
Bull thistle (<i>Cirsium vulgare</i>)	1	13	5
Jerusalem oak (<i>Dysphania botrys</i>)	2	*	*
St. John's wort (<i>Hypericum perforatum</i>)	210	31	110
Hairy cat's ear (<i>Hypochaeris radicata</i>)	*	9	9
Prickly lettuce (<i>Lactuca serriola</i>)	*	20	*
Sheep sorrel (<i>Rumex acetosella</i>)	0	300	*
Woodland groundsel (<i>Senecio sylvaticus</i>)	*	*	122
Dandelion (<i>Taraxacum officinale</i>)	7	77	19
Yellow salsify (<i>Tragopogon dubius</i>)	3	30	*
Mullein (<i>Verbascum thapsus</i>)	0	0	78



Figure 13. Canada thistle (left) and St. John's wort (right); the most difficult to control invasive plants in the Lakeshore Zone. Photos by Sarah Hall.

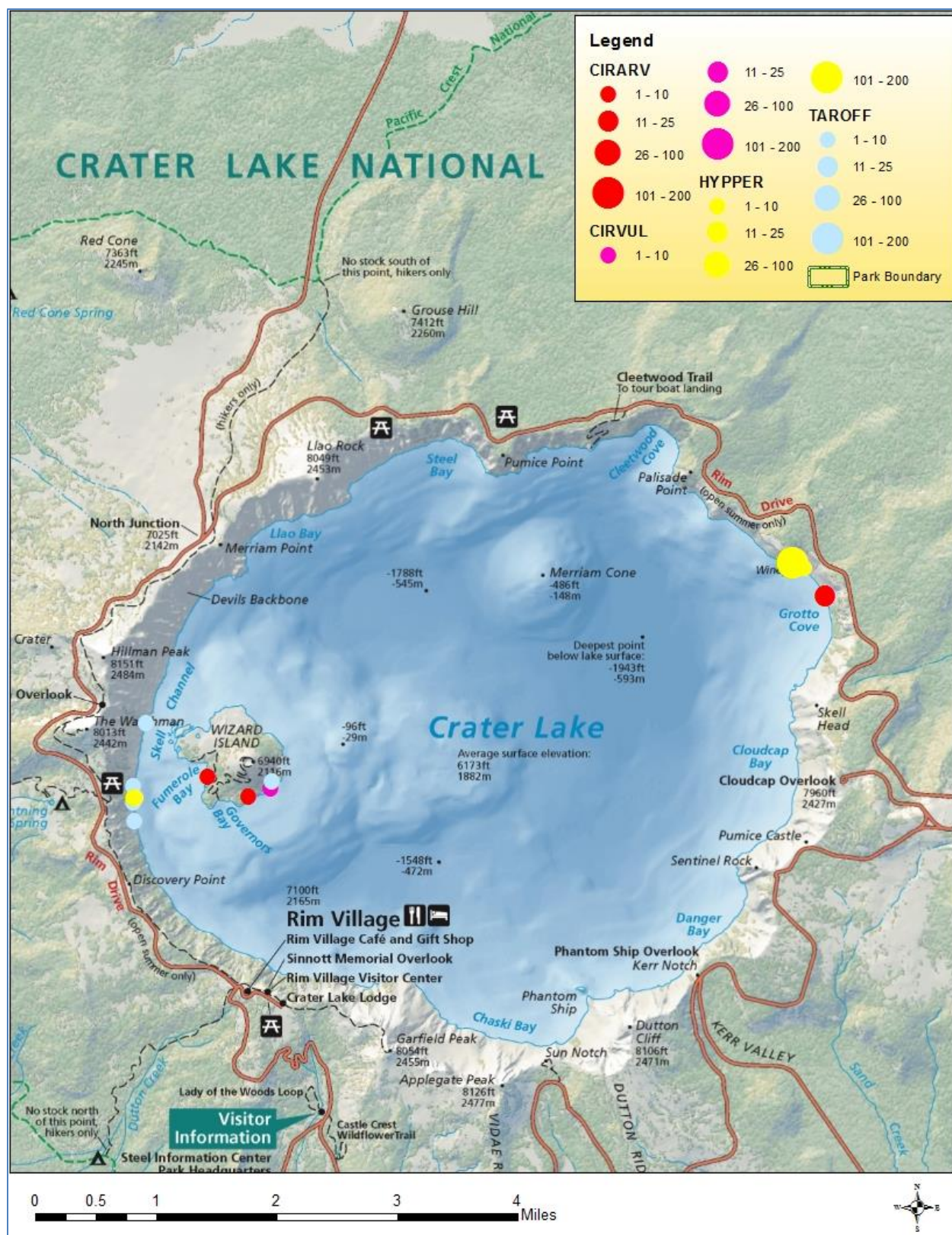


Figure 14. 2017 invasive plant populations in the Lakeshore Zone. CIRARV = Canada thistle; CIRVUL = bull thistle; HYPPER = St. John's wort; TAROFF = dandelion. Map by Jen Hooke.

Roadside Zone

Roads within the Park include Highway 62, Munson Valley Road, West and East Rim Drives, Pinnacles Road, Grayback Road (closed to public motor vehicle traffic), North Entrance Road, and Highway 138. Of these, only Grayback Road has been found to be free of invasive plant species. The greatest concentrations 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 2017, all roads within the Park were surveyed for invasive species with the exceptions of Grayback Road and West Rim Drive; the latter was not surveyed due to extensive road construction and wildfire closures throughout the entire season. Thirty invasive plant species were found along CRLA roadsides including a new species to the Park, wild carrot (*Daucus carota*). Roadside invasive plant locations encountered in 2017 are displayed in Figure 16. Comparisons with findings from the 2015 and 2016 field seasons are made in Tables 8 and 9.

Highway 62 contains the largest and most abundant infestations of invasive plant species with Highway 138 and Munson Valley Road also supporting considerable infestations. West and East Rim Drives contain localized infestations of invasive plant species; portions of these roads have been found to be weed-free but West Rim Drive could not be surveyed in 2017. North Entrance Road is sparsely colonized by invasive plants; very few infestations have been found along this road and most have been associated with the North Entrance Station infrastructure and the junction of Highway 138, and the Pumice Desert overlook.

Spotted knapweed (Figure 15) populations continued their decline in 2017 after many years of regular treatment. More and larger populations of smooth brome (*Bromus inermis*) were discovered along Park roadsides, especially along East Rim Drive. Jerusalem oak (*Dysphania botrys*) populations believed to be introduced during the 2014 Pavement Preservation project continued to see reductions in population sizes from previous years. The invasive annual grass bulbous bluegrass (*Poa bulbosa*) was encountered more frequently in 2017, while cheat grass (*Bromus tectorum*) was not found as abundantly as previous years. The use of herbicide on invasive plant infestations in 2017 was an important step forward in effectively treating plant species that do not respond well to manual treatments, such as sheep sorrel that is one of the most commonly encountered roadside invasive plant species. The increase in number of sheep sorrel plants treated in 2017 was due to the fact that many large populations were triaged in prior years since manual treatment was the only option available for use.



Figure 15. Spotted knapweed blooming alongside Highway 138. Photo by Delacey Randall.

Table 8. Number of invasive plants treated in the Roadside Zone from 2015—2017 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Roadside Zone IVM Region	2017	2016	2015
East Rim Drive	5,665	790	287
Highway 138	9,373	8,281	3,727
Munson Valley Road	4,649	3,692	25,897
North Entrance Road	160	126	337
Pinnacles Road	56	30	*
South Highway 62	24,212	12,441	12,847
West Highway 62	9,530	2,692	3,805
West Rim Drive	*	1,653	1,827
Total	53,645	29,705	48,727

Table 9. Number of invasive plants treated in the Roadside Zone from 2015—2017 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2017	2016	2015
Redtop (<i>Agrostis gigantea</i>)	31	*	*
Meadow foxtail (<i>Alopecurus pratensis</i>)	*	*	8
Tall oatgrass (<i>Arrhenatherum elatius</i> var. <i>elatius</i>)	5	1	*
Yellow rocket (<i>Barbarea vulgaris</i>)	48	*	1
Field mustard (<i>Brassica rapa</i>)	*	*	2
Soft chess (<i>Bromus hordeaceus</i>)	*	1,659	129
Smooth brome (<i>Bromus inermis</i>)	11,235	2,186	2,537
Cheat grass (<i>Bromus tectorum</i>)	71	1,933	2,217
Shepherd's purse (<i>Capsella bursa-pastoris</i>)	*	*	1
Spotted knapweed (<i>Centaurea stoebe</i> ssp. <i>micranthos</i>)	33	58	517
Big chickweed (<i>Cerastium fontanum</i> ssp. <i>vulgare</i>)	*	*	47
Lambs quarters (<i>Chenopodium album</i>)	*	*	1,063
Rush skeletonweed (<i>Chondrilla juncea</i>)	5	3	3
Chicory (<i>Cichorium intybus</i>)	1	*	1
Canada thistle (<i>Cirsium arvensis</i>)	2	*	8
Bull thistle (<i>Cirsium vulgare</i>)	3	33	8
Field bindweed (<i>Convolvulus arvensis</i>)	15	20	17
Wild carrot (<i>Daucus carota</i>)	1	*	*
Tall orchardgrass (<i>Dactylis glomerata</i>)	*	30	20
Flixweed (<i>Descurainia sophia</i>)	*	1	*
Jerusalem oak (<i>Dysphania botrys</i>)	94	1,110	21,454
Quackgrass (<i>Elymus repens</i>)	*	425	186
African filaree (<i>Erodium cicutarium</i>)	*	*	1

Plant Species	2017	2016	2015
Ivy bindweed (<i>Fallopia convolvulus</i>)	*	*	231
Common velvetgrass (<i>Holcus lanatus</i>)	*	14	*
St. John's wort (<i>Hypericum perforatum</i>)	1,572	1,715	4,668
Hairy cat's ear (<i>Hypochaeris radicata</i>)	9	10	3
Dyer's woad (<i>Isatis tinctoria</i>)	31	*	*
Tall lettuce (<i>Lactuca canadensis</i>)	*	4	1
Prickly lettuce (<i>Lactuca serriola</i>)	*	*	35
Field pepperweed (<i>Lepidium campestre</i>)	*	*	28
Purple anther field pepperweed (<i>Lepidium heterophyllum</i>)	410	24	12
Oxeye daisy (<i>Leucanthemum vulgare</i>)	10	60	79
Perennial ryegrass (<i>Lolium perenne</i>)	*	*	8
Birdsfoot trefoil (<i>Lotus corniculatus</i>)	*	*	1
Pineapple weed (<i>Matricaria discoidea</i>)	60	1	1
White sweet clover (<i>Melilotus albus</i>)	*	1	2
Reed canarygrass (<i>Phalaris arundinacea</i>)	*	*	20
Timothy (<i>Phleum pratense</i>)	102	*	78
English plantain (<i>Plantago lanceolata</i>)	*	5	981
Common plantain (<i>Plantago major</i>)	31	5	115
Annual bluegrass (<i>Poa annua</i>)	40	115	*
Bulbous bluegrass (<i>Poa bulbosa</i>)	9,251	2,340	3,900
Kentucky bluegrass (<i>Poa pratensis</i>)	18	*	*
Canada bluegrass (<i>Poa compressa</i>)	*	47	*
Common knotweed (<i>Polygonum aviculare</i> ssp. <i>depressum</i>)	296	30	1,168
Dog rose (<i>Rosa canina</i>)	*	1	*
Sheep sorrel (<i>Rumex acetosella</i>)	23,779	13,608	4,317
Russian thistle (<i>Salsola kali</i> ssp. <i>pontica</i>)	*	*	5
Tansy ragwort (<i>Senecio jacobaea</i>)	67	*	*
Woodland groundsel (<i>Senecio sylvaticus</i>)	*	1	1
Red sandspurry (<i>Spergularia rubra</i>)	*	1,799	1,404
Dandelion (<i>Taraxacum officinale</i>)	4,695	2,137	3,135
Pubescent wheatgrass (<i>Thinopyrum intermedium</i>)	*	*	36
Yellow salsify (<i>Tragopogon dubius</i>)	50	69	165
Scentless mayweed (<i>Tripleurospermum inodorum</i>)	*	1	1
Red clover (<i>Trifolium pratense</i>)	1	1	1
White clover (<i>Trifolium repens</i>)	1,642	188	6
Wheat (<i>Triticum aestivum</i>)	*	*	9
Mullein (<i>Verbascum thapsus</i>)	37	19	96

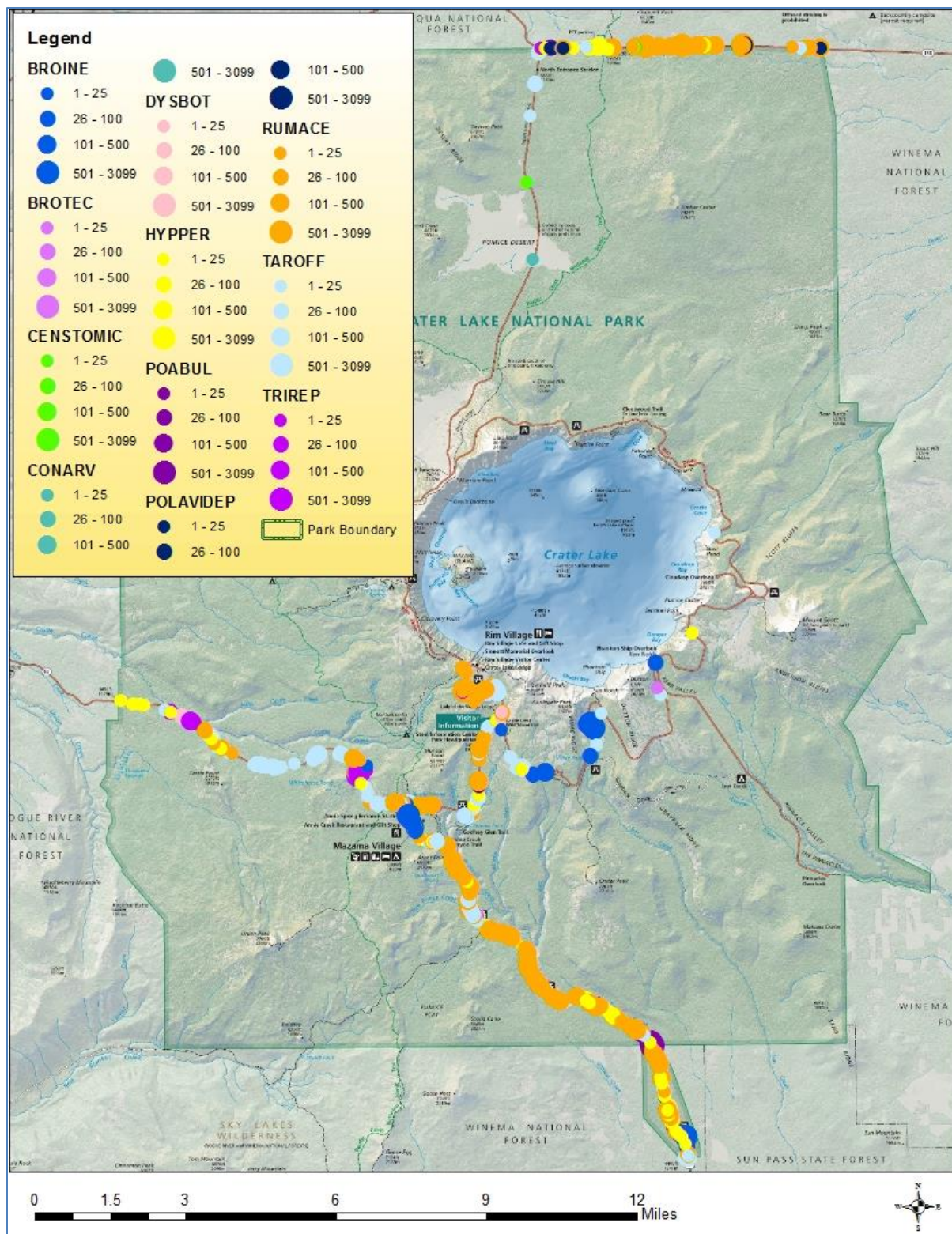


Figure 16. 2017 invasive plant populations in the Roadside Zone. BROINE = smooth brome; BROTEC = cheat grass; CENSTOMIC = spotted knapweed; CONARV = field bindweed; DYSBOT = Jerusalem oak; HYPPER = St. John's wort; POABUL = bulbous bluegrass; POLAVIDEP = common knotweed; RUMACE = sheep sorrel; TAROFF = dandelion; TRIREF = white clover. Map by Jen Hooke.

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 Ballfield) that are used for staging and storage of materials, vehicles, and equipment. These staging areas are often where piles of earthen base materials are stored for road construction projects; where rock is stored and worked for masonry projects (Figure 17); where hazard trees and chipped materials from vegetation clearing are stored and processed; and where various Park materials and supplies are stockpiled and stored for various amounts of time. The staging areas often have heavy equipment working to move and process large piles of materials. 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 throughout the Park, it is vital that the IVM program keeps these areas as free of invasive plant species as possible. Staging area plant locations encountered in 2017 are displayed in Figure 19. Comparisons with findings from the 2015 and 2016 field seasons are made in Tables 10 and 11.



Figure 17. Invasive plants “love” areas subject to disturbance, such as this pile of masonry materials at Roundtop Quarry. Photo by Jen Hooke.

A total of 1,526 invasive plants were encountered throughout the Park’s staging areas in 2017. Red sandspurry was the most common weed encountered in these areas, with the majority located at the Ballfield. The Park’s staging areas continued to be actively used in 2017; Anderson quarry receives the lightest use with materials being moved around and transported by primarily the Trails program. The Pole Bridge Creek and Roundtop quarries receive the heaviest use (Figure 18), with routine use of heavy equipment and large amounts of materials being moved around, staged, and stockpiled. The Blanket Creek fire required that all materials around the perimeter of the South Yard get moved into the middle of the maintenance yard as fire crews needed to create fuel breaks and prepare

the area for fire activity (the fire never ended up burning all the way to the South Yard).

Notable findings include a mullein infestation that worsened in South Yard, and new populations of smooth brome and yellow salsify detected there. There was a reduction in the yellow rocket population at Anderson quarry after several years of regular treatment. There were no weeds detected in Roundtop or Watchman quarries.

Table 10. Number of invasive plants treated in the Staging Area Zone from 2015—2017 by IVM region. Asterisks (*) indicate treatment was missed for a given year.

Staging Area	2017	2016	2015
Anderson Quarry	1	73	25
Ballfield	1,420	*	*
Pole Bridge Creek Quarry	31	239	780
Roundtop Quarry	0	0	0
South Yard	74	16	1,255
Watchman Quarry	0	0	0
Total	1,526	328	2,060

Table 11. Number of invasive plants treated in the Staging Area Zone from 2015—2017 by plant species. Asterisks (*) denote species that weren't encountered and/or treated in a particular year.

Plant Species	2017	2016	2015
Burdock (<i>Arctium minor</i>)	*	*	1
Yellow rocket (<i>Barbarea vulgaris</i>)	11	300	700
Smooth brome (<i>Bromus inermis</i>)	5	*	*
Bull thistle (<i>Cirsium vulgare</i>)	4	*	*
Stinking pepperweed (<i>Lepidium rudemale</i>)	*	*	12
Bulbous bluegrass (<i>Poa bulbosa</i>)	1	*	*
St. John's wort (<i>Hypericum perforatum</i>)	*	5	6
Red sandspurry (<i>Spergularia rubra</i>)	1,432	6	88
Dandelion (<i>Taraxacum officinale</i>)	9	4	1
Yellow salsify (<i>Tragopogon dubius</i>)	31	*	*
Mullein (<i>Verbascum thapsus</i>)	33	13	10

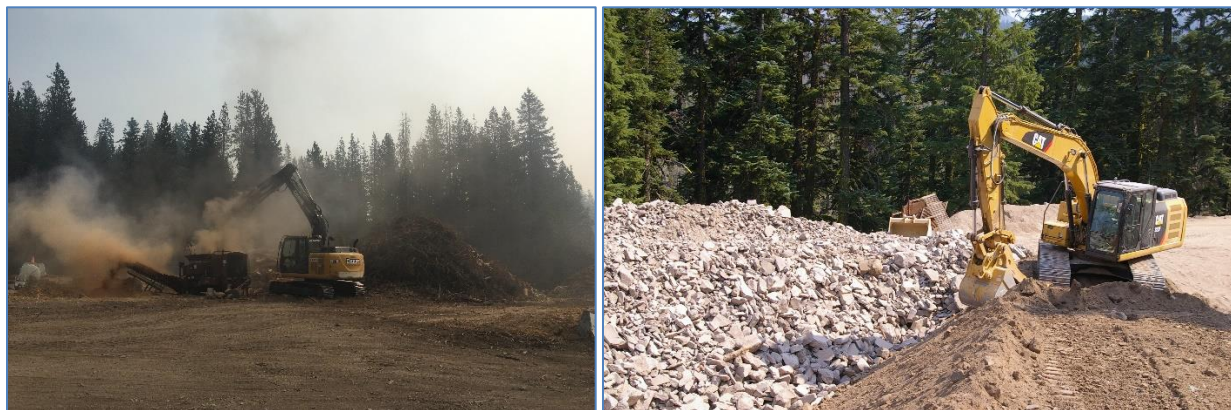


Figure 18. Active use of Park quarries: Pole Bridge Creek (left – Photo by Austin Parker), and Roundtop (right – photo by Andrew Fraser).

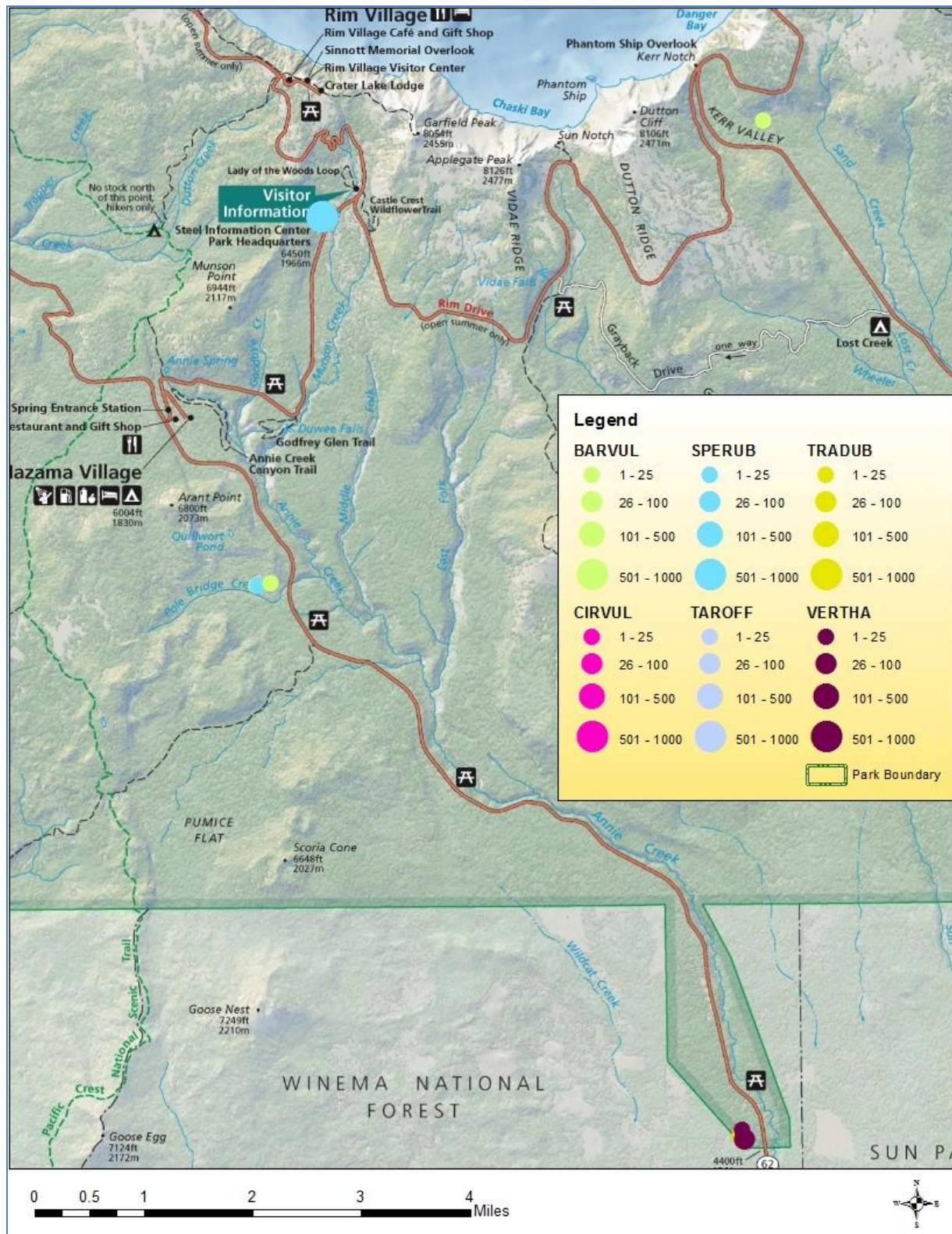


Figure 19. 2017 invasive plant populations in the Staging Area Zone. BARVUL = yellow rocket; CIRVUL = bull thistle; SPERUB = red sandspurry; TAROFF = dandelion; TRADUB = yellow salsify; VERTHA = mullein. Map by Jen Hooke.

Discussion

The 2017 field season brought many challenges and opportunities to the IVM program. A larger crew and a new Invasive Vegetation Management Plan allowed for more effective control of invasive plant species in some areas of the Park. Unfortunately, the severe fire season required the closure of most of the western half of the Park for the majority of the field season. This prevented the survey and treatment of invasive plant species in recently burned areas such as the 2014 Pumice Complex, the 2015 National Creek Complex, and the 2016 Bybee Creek fire areas. Since funding for post-fire invasive plant survey and treatment is limited to only three years post-fire, this was a huge setback to detecting and controlling invasive plants in these areas. There still remains a need for reliable funding to sustain the IVM program, as each year funding is cobbled together from different, unpredictable sources. Keeping regular, sustained momentum going in managing invasive plant species is imperative to protecting the Park's biodiversity.

Large construction projects, such as the Rim Drive Rehabilitation and the well/pipeline construction at Annie Spring and the Pacific Crest Trail trailhead, continue to cause large amounts of ground disturbance, the import of potentially contaminated earthen materials, and increased traffic from heavy equipment and contractor vehicles. Completion of Phase I of the Rim Drive Rehabilitation project has been delayed another year, with planning for Phase II commencing in 2018. Phase II of the Rim Drive Rehabilitation project will impact portions of East Rim Drive. Annual visitation to CRLA in 2017 (711,749 visitors) declined slightly from its peak in 2016 (756,344 visitors) but it is still on the high side as the Park usually receives ~500,000 visitors annually. The increase in visitation can contribute to an increase in invasive plant introductions and infestations as humans and vehicles are important vectors of invasive plant spread.

The invasive plant treatment results from developed areas underscore the need for continuing collaboration with the Park's Revegetation crew. The Revegetation crew handles invasive plant survey and control work at Rim Village, which is one of the most infested areas of the Park. Multiple visits to the Park's developed and staging areas will continue to check invasive plant spread in these areas. The lakeshore zone had a decrease in number of invasive plants encountered compared to previous years; this may be due to high water levels in 2017 plus boat mechanical issues that restricted survey efforts. It is recommended that the lakeshore be surveyed again at two different times to account for early and late blooming species. The IVM crew should make an effort to survey areas and invasive plant populations not visited this year, particularly the Canada thistle populations in Steel Bay and the backside of Wizard Island, both of which need to be accessed by boat.

Burned areas continued to be a source of new invasive plant populations, and there will be more burned areas to survey next year due to the 2017 Spruce Lake (15,825 acres) and Blanket Creek fires (4,510 acres). Due to the vast amount of recently burned acres, it is important to focus on areas that are more susceptible to new infestations. These include areas that experienced direct fire suppression impacts (handlines, spike camps, helispots, and areas affected by aerial retardant drops); areas with prior fire history; and areas that burned with moderate to high severity. Other areas to survey include riparian areas, dry creek beds, and areas with low canopy cover.

The use of herbicide this year greatly increased productivity. It also resulted in less soil disturbance, which is correlated with invasive plant species' spread. The IVM crew was able to spend less time at sites and treat more plants with the use of this treatment method. It will be interesting to compare findings and results with the 2018 field season, as this will be the first time herbicide will be used for a full season and efficacy of 2017 chemical treatments can be assessed.

Additional recommendations for IVM work in 2018 include:

- With the high intensity of construction-related soil disturbance experienced on West Rim Drive and the fact that invasive plant survey and treatment was not possible there in 2017, multiple surveys are recommended for 2018.
- After the discovery of large smooth brome populations on East Rim Drive in 2017, targeted surveying for this species is recommended from Munson Valley Road to Pinnacles Road.
- Cheat grass season was missed in the backcountry in 2017; this should be a high priority in 2018. All known cheat grass (and other annual invasive grasses including soft chess and bulbous bluegrass) sites on roads should be treated with herbicide early and often.
- Sheep sorrel populations throughout the Park senesce late, allowing for herbicide treatment later in the season.
- 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.
- Focus extra attention on sites that were inaccessible in 2017 due to wildfires, especially the Red Blanket Canyon, 2014 Pumice Complex, and 2008 Castle Fire areas.
- Make multiple visits to known Canada thistle sites starting in July.
- 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.
- Go through the protocol for unknown plants with crew members more than once. Ensure unknown plant data forms are complete and the species name is corrected when known.

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