



Early Detection of Invasive Species at Klamath Network Parks in 2017

Natural Resource Data Series NPS/KLMN/NRDS – 2018/1183



ON THE COVER

Scotch broom (*Cytisus scoparius*) growing in ponderosa pine woodland in the Klamath Region.

Photograph by: Dennis Odion (Klamath Network)

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Executive Summary

Every other year since 2009, the Klamath Network Inventory and Monitoring Network (KLMN) has conducted Invasive Species Early Detection (ISED) monitoring at six of the network's parks, including Crater Lake National Park (CRLA), Lassen Volcanic National Park (LAVO), Lava Beds National Monument (LABE), Oregon Caves National Monument and Preserve (ORCA), Redwood National and State Parks (RNSP), and Whiskeytown National Recreation Area (WHIS). The objectives of this monitoring are to detect populations of selected invasive plant species as early as possible in the infestation cycle and immediately provide this information to park management to allow effective management response (Odion et al. 2010).

The KLMN implemented its fourth season of the ISED monitoring from June to September 2017. During the 2017 field season, crews visited each of the six monitored parks roughly at the height of flowering season in each park and in the following approximate order: WHIS, LABE, ORCA, RNSP, LAVO, and CRLA. After incorporating any park-requested changes to the park's sampling frame and/or prioritized invasive plant species list, the network project lead and data manager performed a random, spatially-balanced sample of road and trail segments to be surveyed in each park. Given the efficiency of the 2017 crew, favorable weather, and excellent logistics coordination, the crew not only completed surveys of targeted segments, but also many of the oversample segments. This annual report provides a basic summary of the 2017 field season results.

In total, the crew surveyed 148 road and trail segments (total of 263 km), including 17 segments in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. The crew observed 721 separate infestations. The percentage of park segments infested with the park's prioritized list of invasive species ranged from 3 – 91%. Note that comparisons among parks and among years should be avoided because each park has a unique and evolving list of prioritized species that varies in number and composition; also, sampling frames within parks have changed over time. After the field season, infestation information and maps were provided to each park, and in this report, we provide park-specific results, including survey dates, survey effort, level of infestation by species, abundance maps, and each park's prioritized species list for the 2017 survey.

Introduction

Since 2009, the Klamath Network Inventory and Monitoring (I&M) Network has conducted its Invasive Species Early Detection Monitoring (ISED) Protocol (Odion et al. 2010) every other year at six network parks: Lava Beds National Monument (LBE, or Lava Beds), Oregon Caves National Monument and Preserve (ORCA, or Oregon Caves), Whiskeytown National Recreation Area (WHIS, or Whiskeytown), Crater Lake National Park (CRLA, or Crater Lake), Lassen Volcanic Park (LAVO, or Lassen), and Redwood National and State Parks (RNSP, or Redwood). Note that this monitoring does not occur on the preserve portion of ORCA, which was added in late 2014. The objectives of this monitoring are to detect populations of selected invasive plant species as early as possible in the infestation cycle and provide this information to park management to allow effective management response. This protocol is also designed to make park-wide inferences about infestation rates and collect data for invasive species habitat modeling. In this annual report, results of the 2017 season are described in an abbreviated format to quickly summarize the work completed this field season and assist park managers with targeting their rapid invasive species response efforts.

Methods

Full methodological details are available in the ISED protocol (Odion et al. 2010), but a brief summary is provided below.

Field Preparation

Site Selection

Sampling locations (road and trail segments) are randomly selected during each survey year. Previously surveyed segments are not excluded from the sampling frame and thus may be redrawn in future years. For each park, all roads and trails were broken into 3-km target segments for sampling. Smaller terminal sections were also included. Busy roads posing a safety threat were eliminated from the sampling frame. We then selected a random spatially-balanced sample of segments for each park using the Generalized Random Tessellation Stratified (GRTS) technique (Stevens and Olsen 2004). The number of segments to be visited at each park is based on criteria explained in the Klamath Network ISED Protocol (Odion et al. 2010) and includes a minimum sample size of 25 segments each for WHIS, CRLA, LAVO, and LABE and 35 segments for REDW, due to its large road and trail network. Only the monument portion of ORCA is surveyed, and due to its small size, we survey its 11 road and trail segments in their entirety (i.e., complete census of the monument's roads and trails). Oversample sites (used if sites are inaccessible, dangerous, or time permits extra sampling) were selected at each park, except ORCA. At the request of Redwood staff some segments were removed from the sampling frame, prior to the 2017 sampling season. Segments (both road and trail) were removed by the Redwood staff to condense the KLMN sampling effort. Removal of segments occurred due to segment remoteness (i.e., segments were behind locked gates and have very limited use), or Redwood staff are already actively managing segments for invasive species. We will continue to use the new Redwood sampling frame, for future years, or until Redwood staff desire another sample frame revision.

Species Selection

A separate list of species is monitored for each park. The number and composition of species on each park's list was determined through a prioritization process that used a combination of expert opinion and peer-reviewed publications (Klinger and Brooks 2008). First, lists of non-native species were split into two categories: invasive and non-invasive. Non-invasive species were defined as those that do not transform ecosystems and were subsequently dropped from the prioritization process. The remaining, invasive species were placed into one of three categories representing phases of the invasion process: 1) colonization, 2) establishment, or 3) spread/equilibrium. Species in the colonization phase were considered to be in areas adjacent to each park in the Klamath Network, or they recently colonized a small portion of the park. Species in the establishment phase had multiple, relatively small, localized populations within the boundaries of a park. Species in the spread/equilibrium phase were more widely distributed than those in the establishment phase. Some species in the spread/equilibrium phase were dropped from the list of species to be monitored because control of these species was considered infeasible; other species were to be monitored only in the backcountry (as defined by each park). Each park's species list is evolving over time to meet

park management objectives, and as of 2017, changes are documented in park-specific appendices of this annual report.

Field Methods

Site Sampling

Members of the KLMN Invasive species monitoring crew (Shannon McCoy and Malorie Burris) performed the sampling at the six monitored parks. The field crew traversed each 3-km target segment, starting at the most accessible end. Locations and the size category of each infestation ($<1 \text{ m}^2$, $1\text{-}25 \text{ m}^2$, or $>25 \text{ m}^2$) were recorded. The 3-km segments were divided into 500-m subsegments. If the number of individual species infestations for each subsegment was more than four, or the entire subsegment was considered infested (for management purposes), the crew sampled up to three infestation plots and, always, one random plot, per subsegment. Infestation plots were circular, (radius = 5.6m; area = 100 m^2), centered on the infestation, randomized and spatially balanced among infestations when these were numerous. Crews also randomly placed one circular 100 m^2 plot within 6-20 m of the road or trail in each 500-m subsegment, without regard to location of infestations as shown in an example schematic (Figure 1).

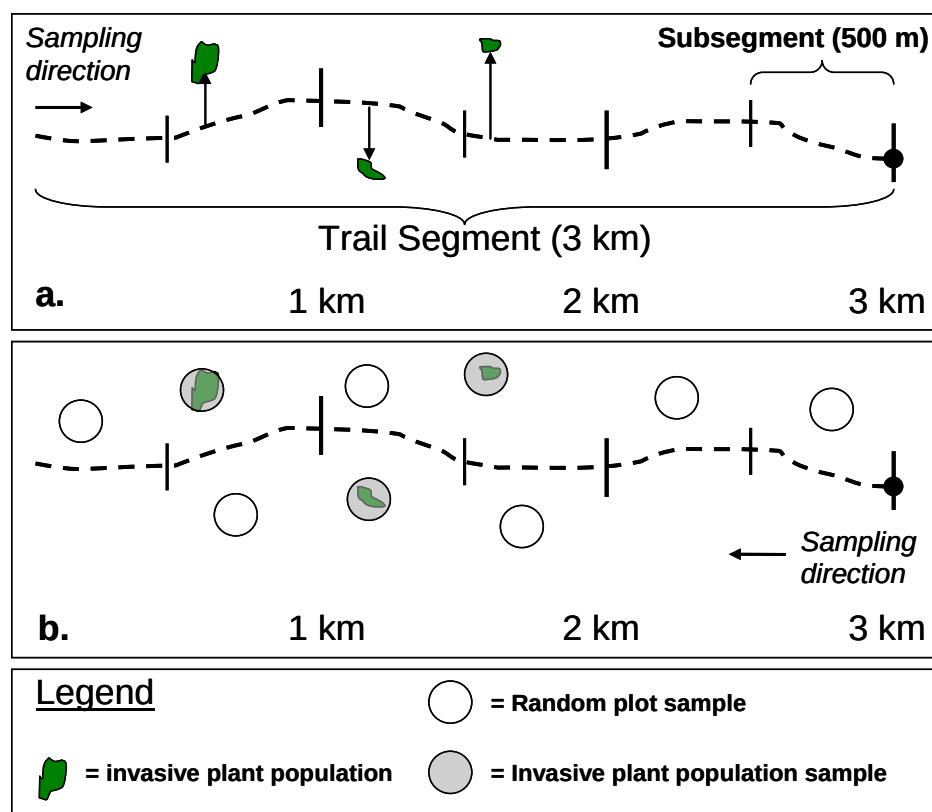


Figure 1. Schematic of segment sampling methodology for the Invasive Species Early Detection protocol. The top portion (a) shows the segment before sampling. The lower portion (b) shows the placement of plots along the segment, see legend for description of plot type.

Locations of random plots are determined before the season and points located using a GPS. In each of these plots (both random and infestation), we sampled the vegetation, environmental variables, and abundance of invasive species (if present) (see list of plot measurements in the next section). Canopy cover was measured with a spherical densiometer.

To the degree feasible, parks were monitored at the time of maximum phenological expression for detecting priority invasive species. However, conditions were not always ideal for all species in all parks.

Invasive Species Early Detection Measurements

Following is the list of Early Detection plot measurements:

- GPS coordinates
- Infestation size
- Infestation % of plot
- Infestation distance from road or trail
- Slope
- Aspect
- Average canopy height
- Percent cover (evergreen, deciduous, herb, shrub, woody debris, litter, bare ground, surface water, soil disturbance)
- Soil disturbance
- Canopy cover (measured with a densiometer)
- Phenology
- Topography (macro and micro position)
- Hydrology
- Land use
- Infestation species

Data Collection

We recorded all data electronically with a Trimble Juno 3B handheld GPS. This was also the primary source of geographical (coordinate) data. In cases where the Trimble could not get satellite reception (which did not occur during the 2017 season), we would have used a Garmin 62st Global Positioning System for location coordinates.

Results

2017 Accomplishments

The Klamath I&M program conducted the fifth season of its Invasive Species Early Detection Protocol from June to September 2017. During the season, the crew visited six parks in the Klamath Network, beginning the season in Whiskeytown, followed by Lava Beds, Oregon Caves, Redwood, Lassen, and concluding at Crater Lake. During the 2017 season the crew visited 148 road and trail segments for a total of 263 km. Total segments per park are as follows: 17 in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. Roads accounted for 42% of surveyed segments while trails were 58%. Not only did the crew accomplish our annual target, they also surveyed many of the over sample segments in parks.

General Patterns of Invasive Species Distribution and Abundance

We observed a total of 1292 separate infestations, and collected site specific environmental data at 583 infestations of thirty-five invasive species. Table 1 shows number of prioritized species for each park and percentage of segments infested at each park. Table 2 shows the prioritized species observed in all six parks and the percentage of segments infested by each species at the parks.

Table 1. Total number of 2017 prioritized species per park and percentage of park segments infested with the park's prioritized list of invasive species in the Klamath Network in 2017.

Park Code	Total # of species on 2017 prioritized list	% of segments infested
RNSP	40	64
LABE	17	97
ORCA	20	27
LAVO	30	16
CRLA	26	29
WHIS	33	73

Table 2. Prioritized invasive species observed in the Klamath Parks and the percentage of segments in the park in 2017. Not all parks have the same target species. If the species is not on the park's target list, it is marked with a dash ('—'). This table only lists target species that were detected in 2017. See the park-specific appendices for a full list of prioritized invasive species.

Species	Crater Lake	Lava Beds	Lassen	Oregon Caves	Redwood	Whiskeytown
<i>Acacia dealbata</i> (mimosa)	—	—	—	—	3	—
<i>Agrostis gigantea</i> (Red Top)	12	—	—	—	—	—
<i>Ailanthus altissima</i> (tree of heaven)	—	—	—	—	—	15
<i>Brassica nigra</i> (black mustard)	—	—	—	—	—	12
<i>Brassica tournefortii</i> (Asian mustard)	—	—	—	—	—	0
<i>Bromus tectorum</i> (Cheatgrass)	0	—	0	0	—	0
<i>Carduus pycnocephalus</i> (Italian thistle)	—	—	—	—	—	4
<i>Centaurea diffusa</i> (Diffuse Knapweed)	0	—	0	—	—	4
<i>Centaurea maculosa</i> (Spotted Knapweed)	0	—	0	0	0	0
<i>Centaurea melitensis</i> (tocalote)	—	—	—	—	—	4
<i>Centaurea solstitialis</i> (Yellow Star Thistle)	0	—	0	0	0	38
<i>Centaurea virgata</i> (Squarrose Knapweed)	—	—	—	—	—	4
<i>Cirsium arvense</i> (Canada Thistle)	0	0	0	—	8	0
<i>Cirsium vulgare</i> (Bull Thistle)	0	3	4	0	44	4
<i>Cortaderia spp.</i> (Pampas Grass)	—	—	—	—	25	—
<i>Cotoneaster spp.</i> (Cotoneaster)	—	—	—	—	0	0
<i>Cytisus scoparius</i> (Scotch Broom)	0	—	0	0	25	0
<i>Dactylis glomerata</i> (Orchard Grass)	0	—	—	0	—	—

Table 2 (continued). Prioritized invasive species observed in the Klamath Parks and the percentage of segments in the park in 2017. Not all parks have the same target species. If the species is not on the park's target list, it is marked with a dash ('—'). This table only lists target species that were detected in 2017. See the park-specific appendices for a full list of prioritized invasive species.

Species	Crater Lake	Lava Beds	Lassen	Oregon Caves	Redwood	Whiskeytown
<i>Descurainia sophia</i> (Pinnate Tansymustard)	—	27	—	—	—	—
<i>Digitalis purpurea</i> (Fox glove)	—	—	—	0	22	—
<i>Dipsacus fullonum</i> (Wild Teasel)	—	—	—	0	2	—
<i>Festuca arundinacea</i> (Tall Fescue)	0	—	—	0	0	0
<i>Foeniculum vulgare</i> (Fennel)	—	—	—	—	4	0
<i>Genista monspessulana</i> (French broom)	—	—	—	—	27	0
<i>Geranium robertianum</i> (Herb Robert)	—	—	—	—	23	—
<i>Hedera helix</i> (Ivy)	—	—	—	—	2	—
<i>Holcus lanatus</i> (Velvet Grass)	0	—	0	0	—	—
<i>Hypericum perforatum</i> (Klamath Weed)	12	—	—	27	25	8
<i>Ilex aquifolium</i> (Holly)	—	—	—	—	6	—
<i>Maribium vulgare</i> (Horehound)	—	3	—	—	—	—
<i>Melilotus spp.</i> (White Sweetclover)	0	15	—	0	—	8
<i>Mentha piperita</i> (Peppermint)	—	—	—	0	—	—
<i>Phalaris aquatica</i> (Harding Grass)	—	—	—	—	0	—
<i>Phalaris arundinacea</i> (Reed Canary Grass)	—	—	0	—	0	—
<i>Phleum pratense</i> (Timothy)	—	—	4	—	—	—
<i>Robinia pseudoacacia</i> (Black locust)	—	—	—	—	—	4

Table 2 (continued). Prioritized invasive species observed in the Klamath Parks and the percentage of segments in the park in 2017. Not all parks have the same target species. If the species is not on the park's target list, it is marked with a dash ('—'). This table only lists target species that were detected in 2017. See the park-specific appendices for a full list of prioritized invasive species.

Species	Crater Lake	Lava Beds	Lassen	Oregon Caves	Redwood	Whiskeytown
<i>Rubus armeniacus</i> (Armenian Blackberry)	—	—	0	9	44	65
<i>Rubus laciniatus</i> (Cut Leaved Blackberry)	—	—	—	—	3	—
<i>Rumex acetosella</i> (Sheep sorel)	18	—	—	—	—	—
<i>Salsola tragus</i> (Russian Thistle)	—	0	—	—	—	—
<i>Senecio jacobaea</i> (Tansy Ragwort)	—	—	—	—	22	—
<i>Taraxacum officinale</i> (Common dandelion)	12	—	—	9	—	—
<i>Tragopogon dubius</i> (Goatsbeard)	6	91	16	—	—	—
<i>Verbascum blattaria</i> (Moth Mullein)	—	—	—	—	—	4
<i>Verbascum thapsus</i> (Common Mullein)	0	24	4	—	0	27

Park-specific Patterns

Appendices A-F provide more detailed information about park-specific survey dates, number and distances of segments completed, segments not completed, and species encountered along with locations and abundance maps.

Discussion

The crew was scheduled to work until the end of September, but their efficiency brought an early end to their season. The ISED protocol was implemented in all six parks for the 2017 field season during periods determined to provide the highest phenological expression of target species. All parks were finished early with the exception of Lava Beds which had its schedule extended to accommodate planning for other parks.

Redwood staff requested a change in the sampling frame. This change brought the sample frame down from 873km to 648km. The two reasons for this change were to remove segments due to remoteness (i.e., segments were behind locked gates and have very limited use), or Redwood staff are already actively managing segments for invasive species, and our efforts would be redundant. The majority of these exclusions were to remote areas, where infestations and new introductions are unlikely.

Literature Cited

- Klinger, R. C., and M. L. Brooks. 2008. Prioritization of non-native plants in the National Park Service Klamath Network using weighted criteria and measures of uncertainty. USGS Technical Report prepared for the National Park Service, Klamath Network. Western Ecological Research Center, US Geological Survey.
- Odion, D. C., D. A. Sarr, S. R. Mohren, and R. C. Klinger. 2010. Invasive species early detection monitoring protocol for Klamath Network parks. Natural Resource Report NPS/KLMN/NRR—2010/227. National Park Service, Fort Collins, Colorado.

Appendix A: Crater Lake National Park

Fiscal Year 2017 Accomplishments

The Klamath I&M program conducted the fifth season of its Invasive Species Early Detection Protocol from June to September 2017. During the season, the crew visited six parks in the Klamath Network, beginning the season in Whiskeytown, followed by Lava Beds, Oregon Caves, Redwood, Lassen Volcanic, and concluding at Crater Lake. During the 2017 season, the crew visited 148 road and trail segments for a total of 263 km. Total segments per park are as follows: 17 in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. Roads accounted for 42% of surveyed segments while trails were 58%. Not only did the crew accomplish our annual target, they also surveyed many of the oversample segments in parks.

Park-specific Findings

CRLA was sampled from September 6th through 9th, while several wildfires within park boundaries created hazardous conditions, closing off the entire western half of the park to sampling. Only 17 segments were safe and accessible for the crew to sample—a total of 32km of roads and trails combined. Of the 17 completed segments, only one—Sun Notch—had an inaccurate route due to a recent large trail rerouting project. The CRLA effort recorded 5 of the 25 prioritized early detection invasive species across the park (Table A.1 and Figure A.1). Species observed include Sheep's Sorrel (*Rumex acetosella*), Redtop (*Agrostis gigantea*), Klamath Weed (*Hypericum perforatum*), Common Dandelion (*Taraxum officinale*), and Goatsbeard (*Tragopogon dubius*). The next section shows the list of prioritized species searched for in 2017.

Table A.1. Summary of prioritized invasive species found at CRLA in 2017, including infestations as a percentage of total segments surveyed at the park. Subsegments are 500m, segments 3km or less.

Species	# of subsegments infested	# of segments infested	% of segments infested
<i>Rumex acetosella</i>	9	3	18
<i>Agrostis gigantea</i>	4	2	12
<i>Hypericum perforatum</i>	4	2	12
<i>Taraxacum officinale</i>	3	2	12
<i>Tragopogon dubius</i>	1	1	6

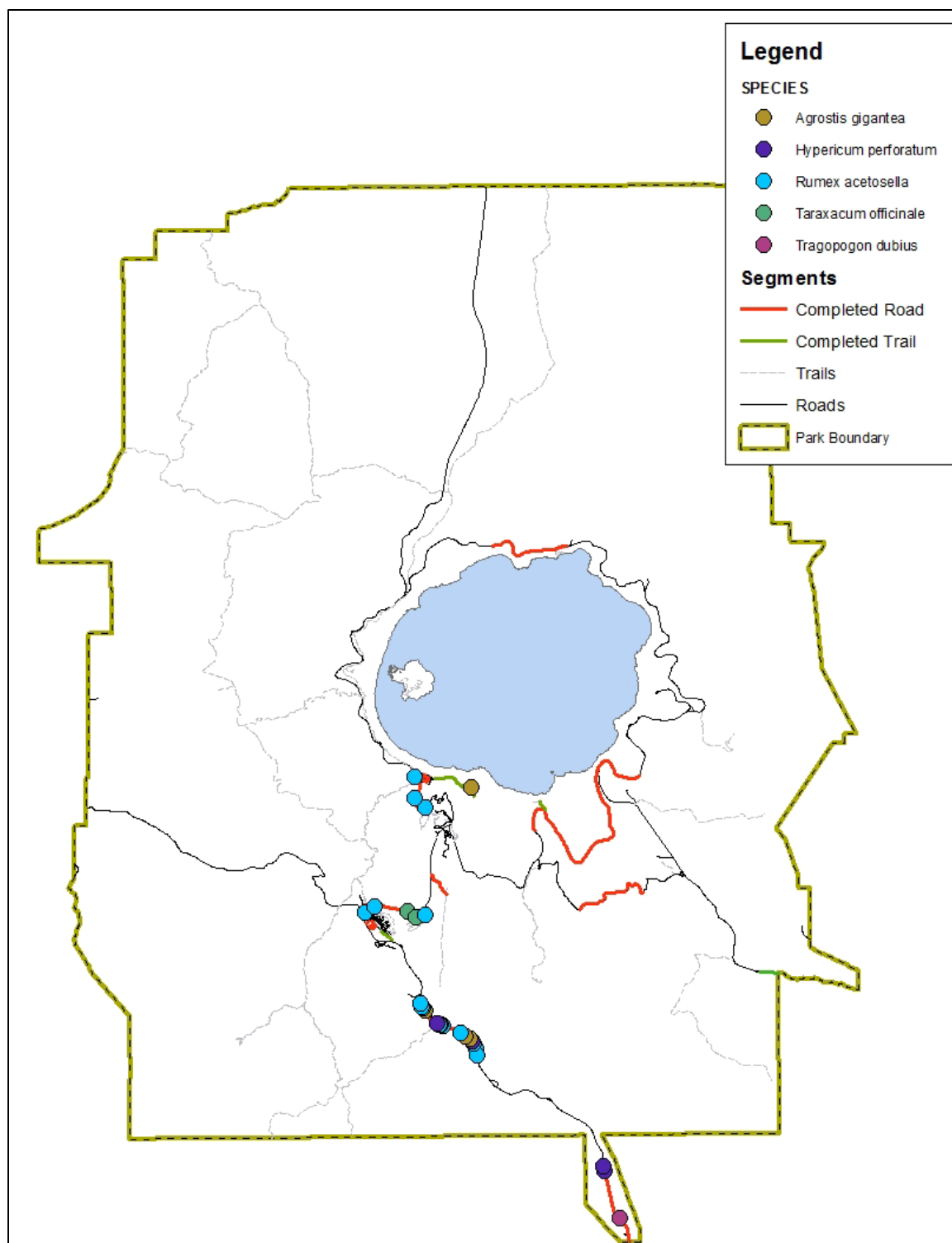


Figure A.1. Locations of invasive plant species recorded from Crater Lake NP in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year.

Crater Lake Prioritized Species for 2017

- *Agrostis gigantea*
- *Brassica rapa*
- *Bromus inermis*
- *Bromus tectorum*
- *Centaurea diffusa*
- *Centaurea maculosa*
- *Centaurea solstitialis*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Cytisus scoparius*
- *Dactylis glomerata*
- *Festuca arundinacea*
- *Holcus lanatus*
- *Hypericum perforatum*
- *Hypochaeris radicata*
- *Lactuca serriola*
- *Leucanthemum vulgare*
- *Linaria genistifolia* ssp. *dalmatica*
- *Melilotus albus*
- *Melilotus officinalis*
- *Poa bulbosa*
- *Rumex acetosella*
- *Senecio sylvaticus*
- *Taraxacum officinale*
- *Tragopogon dubius*
- *Verbascum Thapsus*

Appendix B: Lassen Volcanic National Park

Fiscal Year 2017 Accomplishments

The Klamath I&M program conducted the fifth season of its Invasive Species Early Detection Protocol from June to September 2017. During the season, the crew visited six parks in the Klamath Network, beginning the season in Whiskeytown, followed by Lava Beds, Oregon Caves, Redwood, Lassen Volcanic, and concluding at Crater Lake. During the 2017 season, the crew visited 148 road and trail segments for a total of 263 km. Total segments per park are as follows: 17 in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. Roads accounted for 42% of surveyed segments while trails were 58%. Not only did the crew accomplish our annual target, they also surveyed many of the oversample segments in parks.

Park-specific Findings

LAVO was sampled between August 22nd and 29th, with 26 segments completed and a total of 53km of combined roads and trails surveyed. The LAVO effort recorded 4 of the 30 prioritized early detection invasive species across the park (Table B.1 and Figure B.1). The species were Goatsbeard (*Tragopogon dubius*), Bull Thistle (*Cirsium vulgare*), Common Mullein (*Verbascum thapsus*), and Timothy-grass (*Phleum pratense*). The next section shows the list of prioritized species searched for in 2017.

Table B.1. Summary of prioritized invasive species found at LAVO in 2017, including infestations as a percentage of total segments surveyed at the park. Subsegments are 500m, segments 3km or less.

Species	# of subsegments infested	# of segments infested	% of segments infested
<i>Tragopogon dubius</i>	12	4	16
<i>Cirsium vulgare</i>	2	1	4
<i>Verbascum thapsus</i>	1	1	4
<i>Phleum pratense</i>	1	1	4

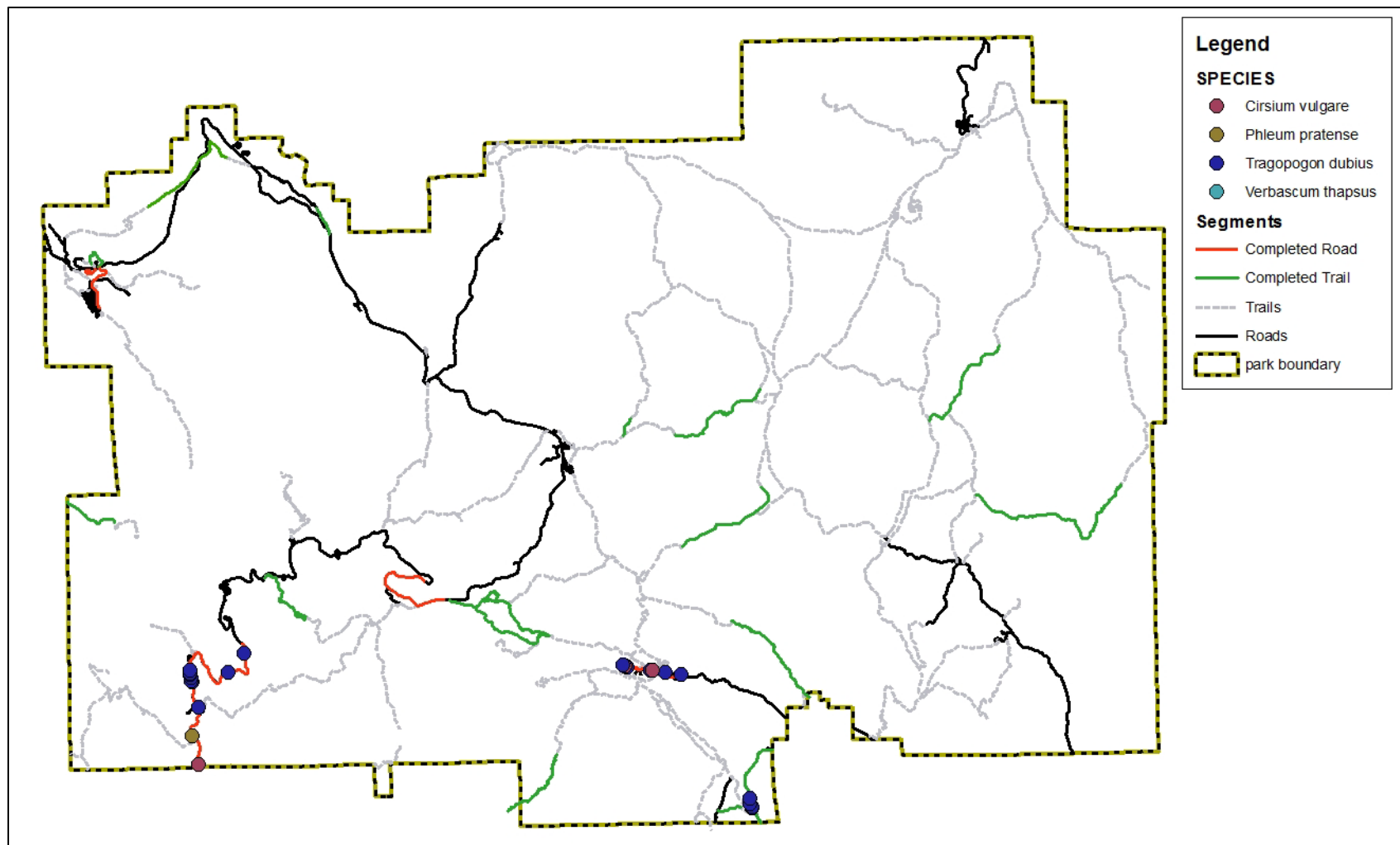


Figure B.1. Locations of invasive plant species recorded from Lassen Volcanic NP in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year.

Several closed or unmaintained trails, mislayered segments, and a potentially hazardous river crossing posed challenges to the crew's ability to sample. Willow Lake A was not a trail, but actually an ephemeral stream. Warner Valley to Willow Lake A only existed from subsegments 1-3, with 4 and 5 nonexistent. Segment 29N75 could not be sampled due to the Warner Valley to Willow Lake A not extending to this segment as the map suggests, and also due to private property that could not be crossed to enter from the north end. Drake Lake to Panther Creek B had a passable trail within subsegments 1 and 2, but 3-5 were unmaintained or completely nonexistent, and required the use of GPS and compass to follow. Kings Creek A was only sampled through subsegment 5, due to a potentially unsafe river crossing, as the mode of crossing washed out during winter 2017. Blue Lake A required using the GPS to navigate during some points; this trail has evidently been decommissioned due to the removal of NPS signage, but appears to be used sometimes and has not gone through any restoration. Furthermore, a section of subsegment 3 of the Kings Creek Falls Loop A was closed due to dangerous conditions and is undergoing repairs.

Lassen Prioritized Species for 2017

- *Acroptilon repens*
- *Bromus tectorum*
- *Cardaria draba*
- *Carduus nutans*
- *Carduus pycnocephalus*
- *Centaurea diffusa*
- *Centaurea maculosa*
- *Centaurea solstitialis*
- *Centaurea virgata*
- *Chondrilla juncea*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Cytisus scoparius*
- *Euphorbia esula*
- *Genista monspessulana*
- *Halogeton glomeratus*
- *Hirschfeldia incana*
- *Holcus lanatus*
- *Isatis tinctoria*
- *Lepidium latifolium*
- *Linaria genistifolia* ssp. *Dalmatica*

- *Lythrum salicaria*
- *Onopordum acanthium*
- *Phalaris arundinacea*
- *Phleum pretense*
- *Poa bulbosa*
- *Rubus armeniacus*
- *Taeniatherum caput-medusae*
- *Tragopogon dubius*
- *Verbascum thapsus*

Appendix C: Lava Beds National Monument

Fiscal Year 2017 Accomplishments

The Klamath I&M program conducted the fifth season of its Invasive Species Early Detection Protocol from June to September 2017. During the season, the crew visited six parks in the Klamath Network, beginning the season in Whiskeytown, followed by Lava Beds, Oregon Caves, Redwood, Lassen Volcanic, and concluding at Crater Lake. During the 2017 season, the crew visited 148 road and trail segments for a total of 263 km. Total segments per park are as follows: 17 in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. Roads accounted for 42% of surveyed segments while trails were 58%. Not only did the crew accomplish our annual target, they also surveyed many of the oversample segments in parks.

Park-specific Findings

Lava Beds was sampled between June 30th and July 13th, the height of the flowering season for most invasive species, and 33 segments, or 60km, of combined roads and trails were surveyed. The Lava Beds effort recorded 5 of the 17 prioritized early detection invasive species across the park (Table C.1 and Figure C.1). The species, in descending order of abundance, included: Goatsbeard (*Tragopogon dubius*), Flix Weed (*Descurainia Sophia*), Common Mullein (*Verbascum thapsus*), Sweetclover (*Melilotus spp.*), Bull Thistle (*Cirsium vulgare*), and Common Horehound (*Marrubium vulgare*). The next section shows the list of prioritized species searched for in 2017.

The following trails required using a GPS to follow, as the trails do not appear to be maintained for use: Sheepherder A, Western Guano A, Guano Bridge A, and Guano Bridge B.

Table C.1. Summary of prioritized invasive species found at LABE in 2017, including infestations as a percentage of total segments surveyed at the park. Subsegments are 500m, segments 3km or less.

Species	# of subsegments infested	# of segments infested	% of segments infested
<i>Tragopogon dubius</i>	122	30	91
<i>Descurainia sophia</i>	16	9	27
<i>Verbascum thapsus</i>	20	8	24
<i>Melilotus ssp.</i>	9	5	15
<i>Cirsium vulgare</i>	1	1	3
<i>Marrubium vulgare</i>	1	1	3

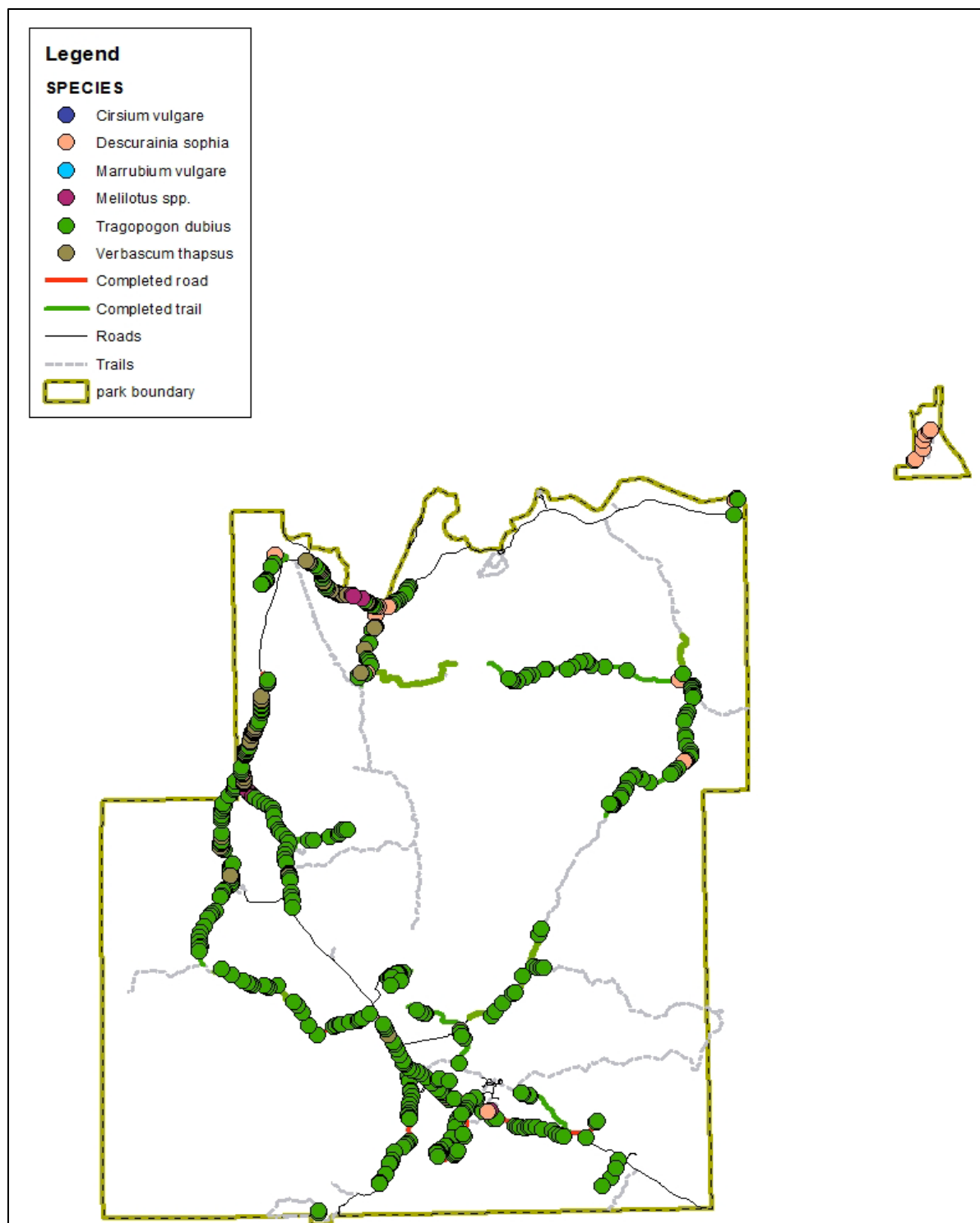


Figure C.1. Locations of invasive plant species recorded from Lava Beds NM in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year.

Lava Beds Prioritized Species for 2017

- *Centaurea solstitialis*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Descurainia Sophia*
- *Isatis tinctoria*
- *Kochia scoparia*
- *Lepidium latifolium*
- *Lepidium perfoliatum*
- *Linaria genistifolia* ssp. *Dalmatica*
- *Marrubium vulgare*
- *Melilotus* spp.
- *Salsola tragus*
- *Taeniatherum caput-medusae*
- *Thlaspi arvense*
- *Torilis arvensis*
- *Tragopogon dubius*
- *Verbascum thapsus*

Appendix D: Oregon Caves National Monument and Preserve

Fiscal Year 2017 Accomplishments

The Klamath I&M program conducted the fifth season of its Invasive Species Early Detection Protocol from June to September 2017. During the season, the crew visited six parks in the Klamath Network, beginning the season in Whiskeytown, followed by Lava Beds, Oregon Caves, Redwood, Lassen Volcanic, and concluding at Crater Lake. During the 2017 season, the crew visited 148 road and trail segments for a total of 263 km. Total segments per park are as follows: 17 in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. Roads accounted for 42% of surveyed segments while trails were 58%. Not only did the crew accomplish our annual target, they also surveyed many of the oversample segments in parks.

Park-specific Findings

Oregon Caves was sampled between July 24 and July 26, to capture the peak flowering season for most invasive species, and 11 segments, or 11.9 km of combined roads and trails were surveyed. The Oregon Caves effort recorded three of the 20 prioritized early detection invasive species across the park (Table D.1 and Figure D.1): St. Johns wart (*Hypericum perforatum*), Himalayan blackberry (*Rubus armeniacus*), and Common dandelion (*Taraxacum officinale*). The next section shows the list of prioritized species searched for in 2017. *Mentha* was originally reported but unlikely to be found in the specified location, thus removed from the final report.

Table D.1. Summary of prioritized invasive species found at ORCA in 2017, including infestations as a percentage of total segments surveyed at the park. Subsegments are 500m, segments 3km or less.

Species	# of subsegments infested	# of segments infested	% of segments infested
<i>Hypericum perforatum</i>	4	3	27
<i>Rubus armeniacus</i>	1	1	9
<i>Taraxacum officinale</i>	1	1	9

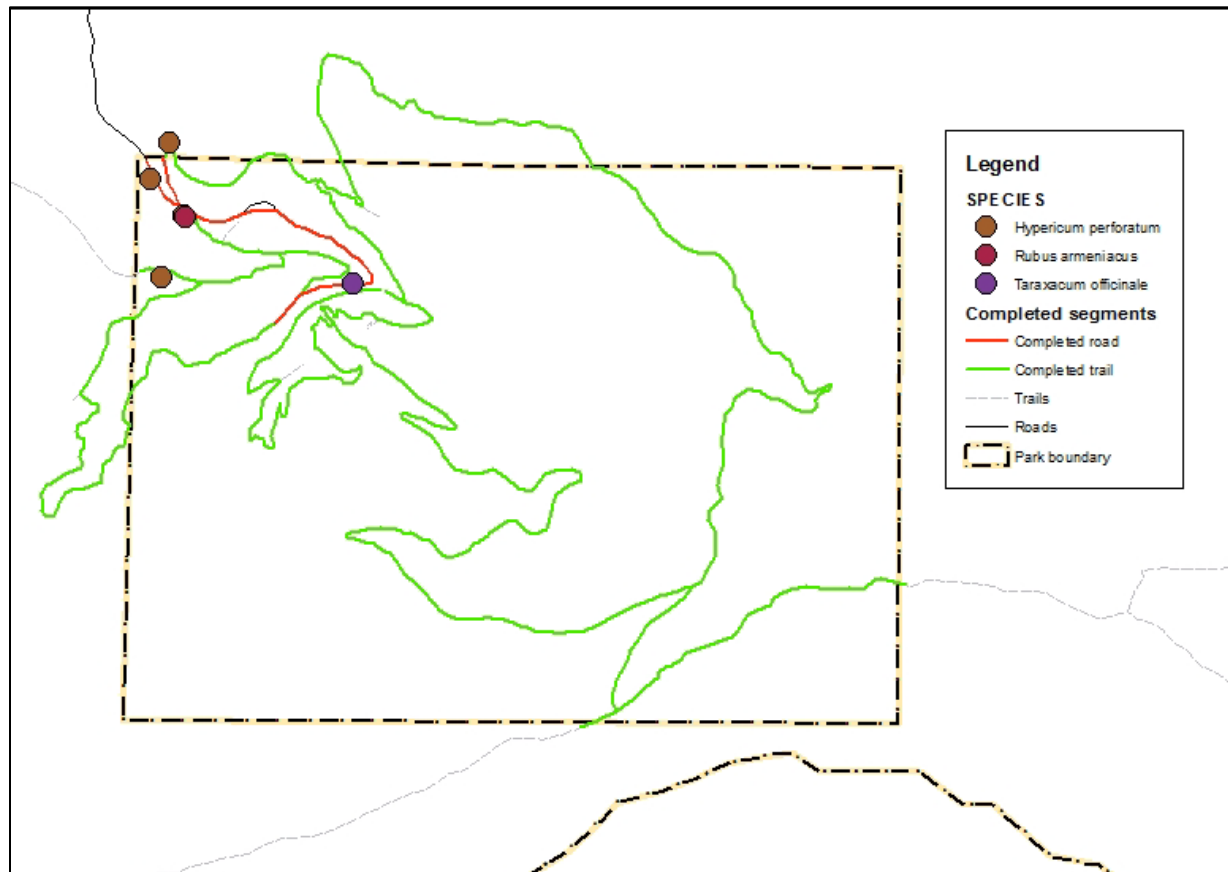


Figure D.1. Locations of invasive plant species recorded from Oregon Caves NMP in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year.

Oregon Caves Prioritized Species for 2017

- *Bromus tectorum*
- *Centaurea maculosa*
- *Centaurea solstitialis*
- *Cirsium vulgare*
- *Cytisus scoparius*
- *Dactylis glomerata*
- *Digitalis purpurea*
- *Dipsacus fullonum*
- *Festuca arundinacea*
- *Holcus lanatus*
- *Hypericum perforatum*
- *Lathyrus sylvestris*
- *Leucanthemum vulgare*
- *Melilotus albus*
- *Mentha piperita*
- *Rubus armeniacus*
- *Rubus laciniatus*
- *Rumex obtusifolius*
- *Taraxacum officinale*
- *Verbascum thapsus*

Appendix E: Redwood National and State Parks

Fiscal Year 2017 Accomplishments

The Klamath I&M program conducted the fifth season of its Invasive Species Early Detection Protocol from June to September 2017. During the season, the crew visited six parks in the Klamath Network, beginning the season in Whiskeytown, followed by Lava Beds, Oregon Caves, Redwood, Lassen Volcanic, and concluding at Crater Lake. During the 2017 season, the crew visited 148 road and trail segments for a total of 263 km. Total segments per park are as follows: 17 in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. Roads accounted for 42% of surveyed segments while trails were 58%. Not only did the crew accomplish our annual target, they also surveyed many of the oversample segments in parks.

Park-specific Findings

RNSP was sampled between July 27 and August 14, the height of the flowering season for most invasive species, and 36 segments of 65 km combined roads and trails were surveyed. The RNSP effort recorded 16 of the 39 prioritized early detection invasive species across the park (Table E.1 and Figures E.1, E.2, and E.3). The species, in descending order of abundance, included: Himalayan Blackberry (*Rubus armeniacus*), Bull Thistle (*Cirsium vulgare*), Tansy Ragwort (*Senecio jacobea*), Pampas Grass (*Cortaderia* spp.), Scotch Broom (*Cystisus scoparius*), St. John's Wort (*Hypericum perforatum*), Foxglove (*Digitalis purpurea*), French broom (*Genista monspessulana*), Herb Robert (*Geranium robertianum*), Canada thistle (*Cirsium arvense*), Fennel (*Foeniculum vulgare*), Common holly (*Ilex aquifolium*), mimosa (*Acacia dealbata*), Teasel (*Dipsacus fullonum*), English Ivy (*Hedera helix*), Cutleaf blackberry (*Rubus lacinatus*). The next section shows the list of prioritized species searched for in 2017.

The following trails posed field challenges for the crew. Fern Falls Trail A is only accessible from the Boy Scout Trail, not from a road within a nearby neighborhood as the current RNSP trail data suggests. Subsegment 2 on over sample Upper Visser-1 Road (Mill Creek) does not exist; the trail/road simply ends. The West Ridge Trail A appears not to exist anymore and is misnamed as West Ridge Trail, which is the trail that this segment should have intersected with. The tiny C.R.E.A. Grove Trail A segment no longer exists.

Table E.1. Summary of prioritized invasive species found at RNSP in 2017, including infestations as a percentage of total segments surveyed at the park. Subsegments are 500m, segments 3km or less.

Species	# of subsegments infested	# of segments infested	% of segments infested
<i>Cirsium vulgare</i>	45	16	44
<i>Rubus armeniacus</i>	43	16	44
<i>Cortaderia spp.</i>	22	9	25
<i>Cytisus scoparius</i>	18	9	25
<i>Genista monspessulana</i>	18	9	25
<i>Hypericum perforatum</i>	21	9	25
<i>Digitalis purpurea</i>	18	8	22
<i>Senecio jacobaea</i>	22	8	22
<i>Geranium robertianum</i>	16	4	11
<i>Cirsium arvense</i>	4	3	8
<i>Foeniculum vulgare</i>	2	2	6
<i>Ilex aquifolium</i>	2	2	6
<i>Acacia dealbata</i>	1	1	3
<i>Dipsacus fullonum</i>	1	1	3
<i>Hedera helix</i>	1	1	3
<i>Rubus laciniatus</i>	2	1	3

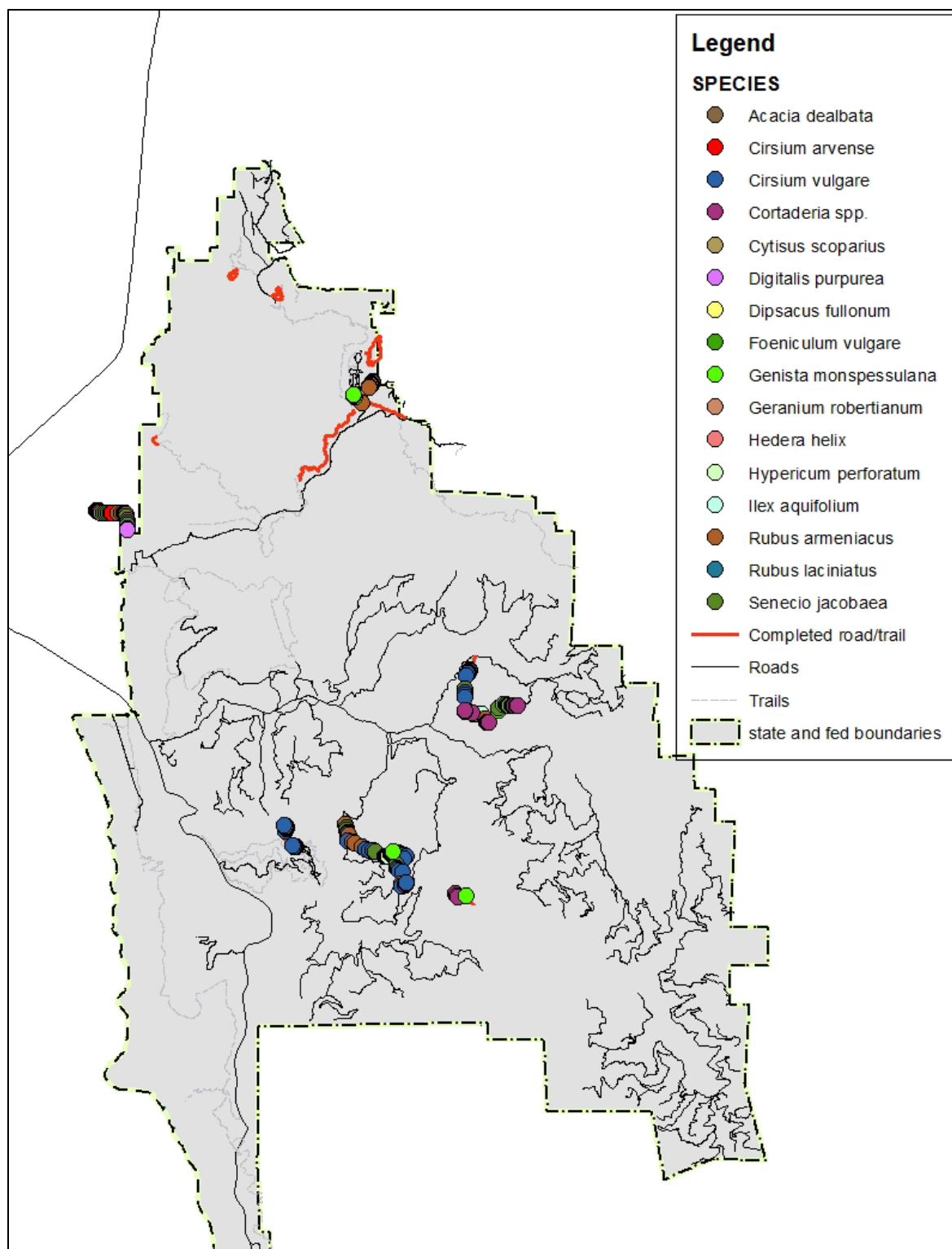


Figure E.1. Locations of invasive plant species recorded from the north portion of Redwood NSP in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year. Portions of the park not shown lack visited segments.

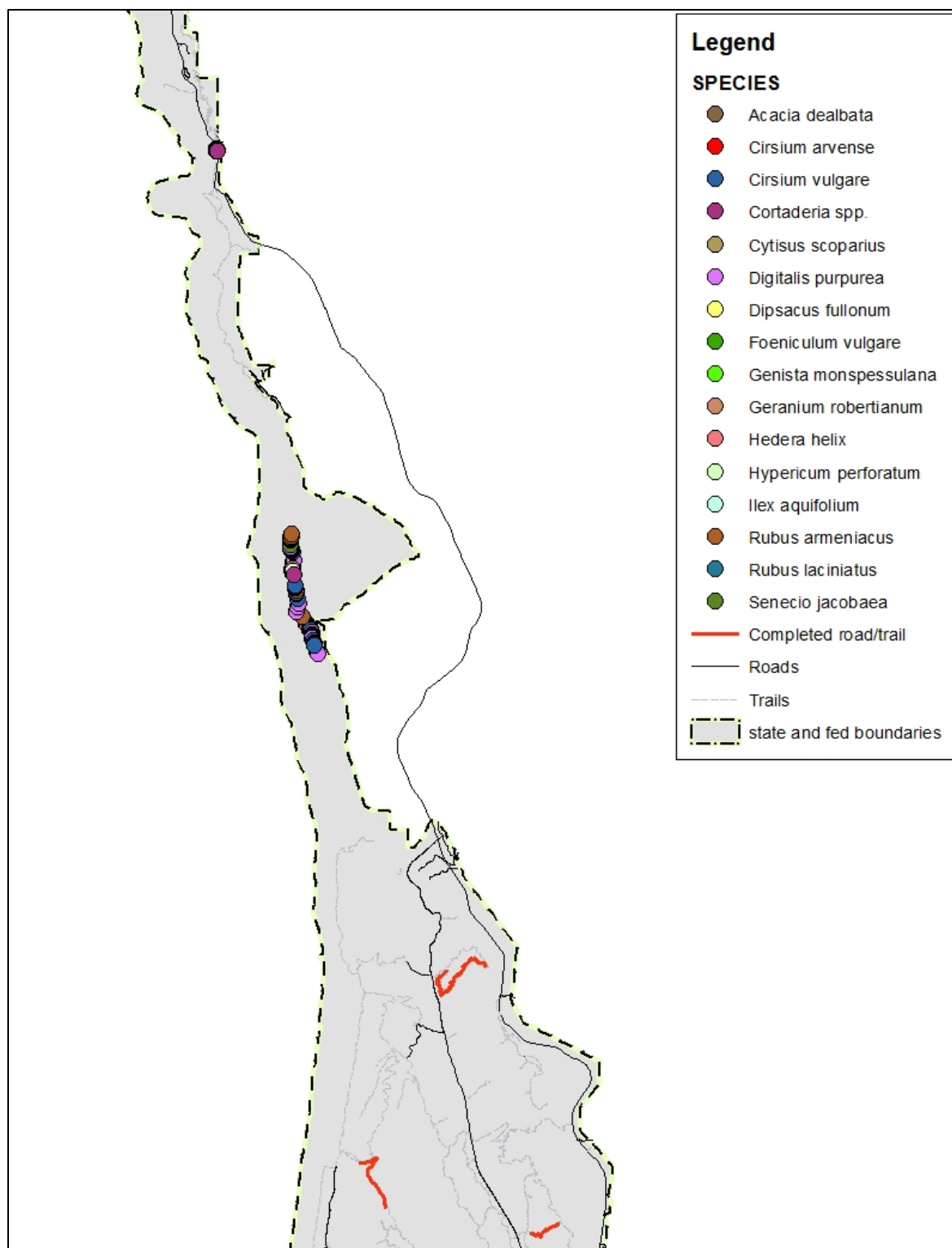


Figure E.2. Locations of invasive plant species recorded from the central portion of Redwood NSP in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year. Portions of the park not shown lack visited segments.

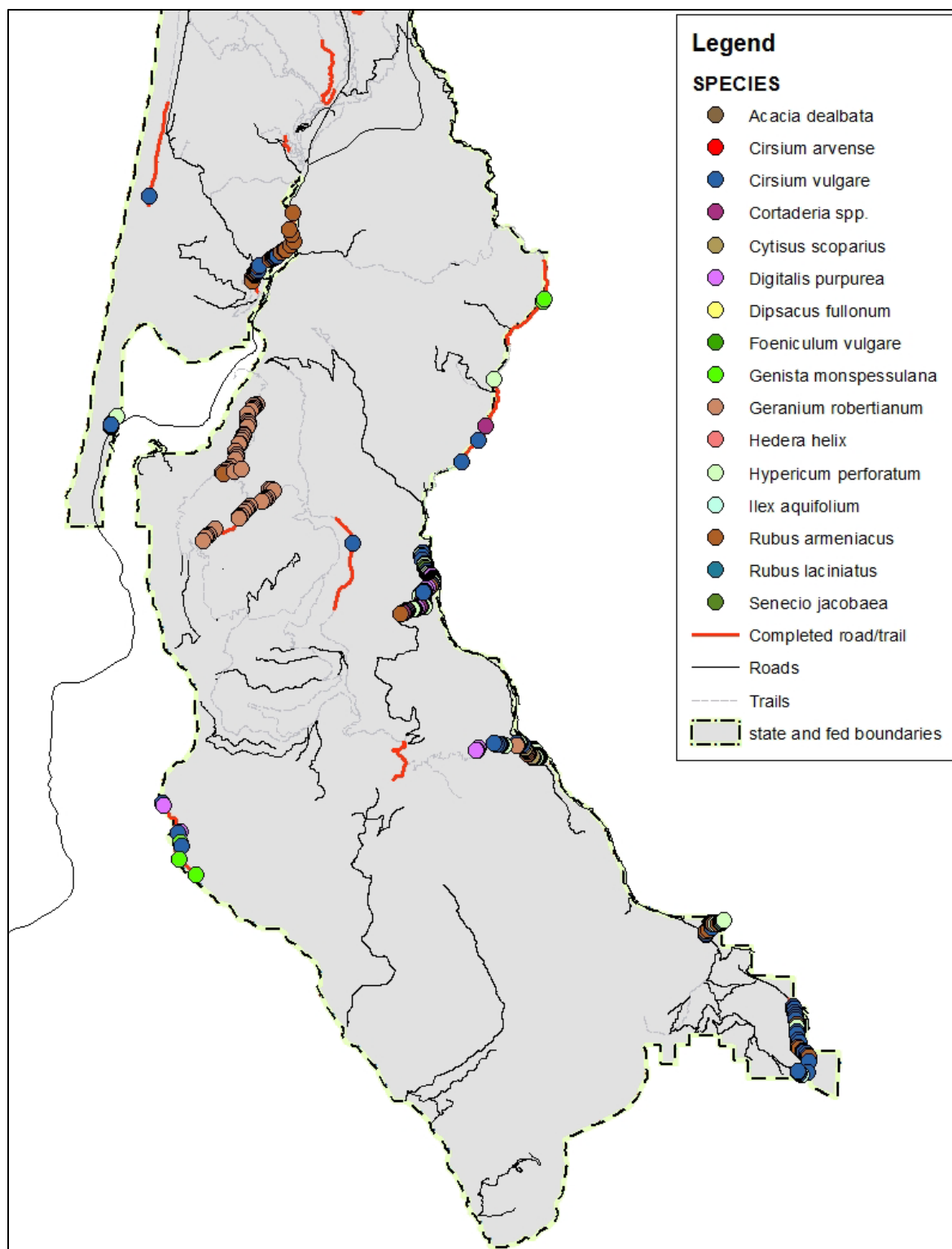


Figure E.3. Locations of invasive plant species recorded from the south portion of Redwood NSP in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year. Portions of the park not shown lack visited segments.

Redwood Prioritized Species for 2017

- *Acacia dealbata*
- *Allium triquetrum*
- *Carpobrotus chilensis*
- *Centaurea maculosa*
- *Centaurea solstitialis*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Cortaderia* spp.
- *Cotoneaster* spp.
- *Crataegus monogyna*
- *Cytisus scoparius*
- *Delairea odorata*
- *Digitalis purpurea*
- *Dipsacus fullonum*
- *Erica lusitanica*
- *Festuca arundinacea*
- *Foeniculum vulgare*
- *Genista monspessulana*
- *Geranium lucidum*
- *Geranium robertianum*
- *Hedera helix*
- *Hypericum perforatum*
- *Ilex aquifolium*
- *Linaria genistifolia* ssp. *dalmatica*
- *Lupinus arboreus*
- *Phalaris aquatic*
- *Phalaris arundinacea*
- *Pinus radiata*
- *Polygonum* spp.
- *Polygonum sachalinense*
- *Prunus avium*

- *Robinia pseudoacacia*
- *Rubus armeniacus*
- *Rubus laciniatus*
- *Senecio jacobaea*
- *Silybum marianum*
- *Ulex europaeus*
- *Verbascum thapsus*
- *Vinca major*

Appendix F: Whiskeytown National Recreation Area

Fiscal Year 2017 Accomplishments

The Klamath I&M program conducted the fifth season of its Invasive Species Early Detection Protocol from June to September 2017. During the season, the crew visited six parks in the Klamath Network, beginning the season in Whiskeytown, followed by Lava Beds, Oregon Caves, Redwood, Lassen Volcanic, and concluding at Crater Lake. During the 2017 season, the crew visited 148 road and trail segments for a total of 263 km. Total segments per park are as follows: 17 in CRLA, 25 in LAVO, 33 in LABE, 11 in ORCA, 36 in RNSP, and 26 in WHIS. Roads accounted for 42% of surveyed segments while trails were 58%. Not only did the crew accomplish our annual target, they also surveyed many of the oversample segments in parks.

Park-specific Findings

Whiskeytown was sampled between June 12 and June 22, and 26 segments, or 44 km, of combined roads and trails were surveyed. The Whiskeytown effort recorded 14 of the 33 prioritized early detection invasive species across the park (Table F.1 and Figure F.1). The next section shows the list of prioritized species searched for in 2017.

Segments that posed challenges to the crew included: On the Oak Bottom Water Ditch Loop A segment, the second subsegment has been decommissioned. Unnamed A trail has also been decommissioned and was not surveyed.

Table F.1. Summary of prioritized invasive species found at WHIS in 2017, including infestations as a percentage of total segments surveyed at the park. Subsegments are 500m, segments 3km or less.

Species	# of subsegments infested	# of segments infested	% of segments infested
<i>Rubus armeniacus</i>	54	17	65
<i>Centaurea solstitialis</i>	28	10	38
<i>Verbascum thapsus</i>	13	7	27
<i>Ailanthus altissima</i>	8	4	15
<i>Brassica nigra</i>	9	3	12
<i>Hypericum perforatum</i>	2	2	8
<i>Melilotus albus</i>	2	2	8
<i>Carduus pycnocephalus</i>	1	1	4
<i>Centaurea diffusa</i>	4	1	4
<i>Centaurea melitensis</i>	2	1	4
<i>Centaurea virgata</i>	2	1	4

Table F.1 (continued). Summary of prioritized invasive species found at WHIS in 2017, including infestations as a percentage of total segments surveyed at the park. Subsegments are 500m, segments 3km or less.

Species	# of subsegments infested	# of segments infested	% of segments infested
<i>Cirsium vulgare</i>	2	1	4
<i>Robinia pseudoacacia</i>	3	1	4
<i>Verbascum blattaria</i>	5	1	4

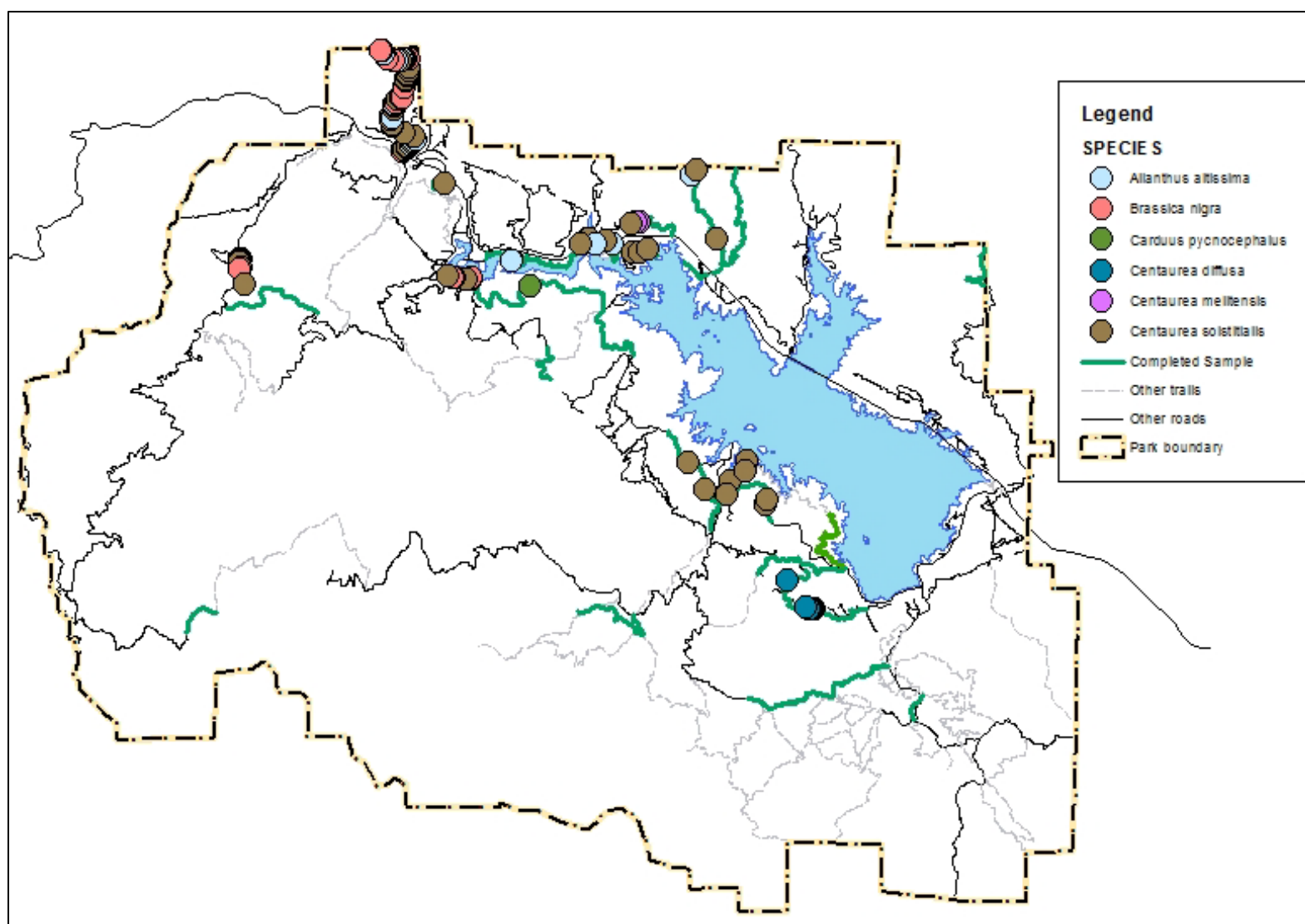


Figure F.1. Locations of invasive plant species recorded from Whiskeytown NRA in the 2017 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year; roads and trails in black were not sampled this fiscal year.

Whiskeytown Prioritized Species for 2017

- *Aegilops triuncialis*
- *Ailanthus altissima*
- *Arundo donax*
- *Brassica nigra*
- *Brassica tournefortii*
- *Bromus tectorum*
- *Carduus pycnocephalus*
- *Catalpa bignoides*
- *Centaurea diffusa*
- *Centaurea melitensis*
- *Centaurea solstitialis*
- *Centaurea stoebe* ssp. *Micranthos*
- *Centaurea virgate*
- *Chondrilla juncea*
- *Cirsium arvense*
- *Cirsium vulgare*
- *Cytisus scoparius*
- *Dittrichia Graveolens*
- *Elymus Caput-medusae*
- *Euphorbia oblongata*
- *Foeniculum vulgare*
- *Genista monspessulana*
- *Isatis tinctoria*
- *Lepidium latifolium*
- *Linaria dalmatica* ssp. *Dalmatica*
- *Marrubium vulgare*
- *Melilotus albus*
- *Robinia pseudoacacia*
- *Rubus armeniacus*
- *Sparticum junceum*
- *Tamarix chinensis*
- *Tribulus terrestris*

- *Verbascum thapsus*

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

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National Park Service
U.S. Department of the Interior



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