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Natural Resource Stewardship and Science

Klamath Network Invasive Species Early Detection:

2015 Annual Report

Natural Resource Report NPS/KLMN/NRR—2016/1215

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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2015 Annual Report

Natural Resource Report NPS/KLMN/NRR—2016/1215

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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 April to August 2015. During the 2015 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 2015 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 2015 field season results. In total, the crew surveyed 168 road and trail segments (total of 309 km), including 27 segments in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. The crew observed a total of 325 separate infestations of twenty-six priority invasive species. The percentage of park segments infested with the park's prioritized list of invasive species ranged from 6 – 73%. 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 2015 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 (LABE, 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 2015 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 2015 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 2015, changes are documented in park-specific appendices of this annual report. Before the beginning of the 2011 season, minor modifications occurred to the prioritization lists at CRLA, LABE, and WHIS based on park staff knowledge of emerging invasive species.

Field Methods

Site Sampling

Members of the KLMN Invasive species monitoring crew (Ian Whited and Nate Moore) 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 m^2, 1-25 m^2, or >25 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 6-14 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), 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) (Table 1). 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.

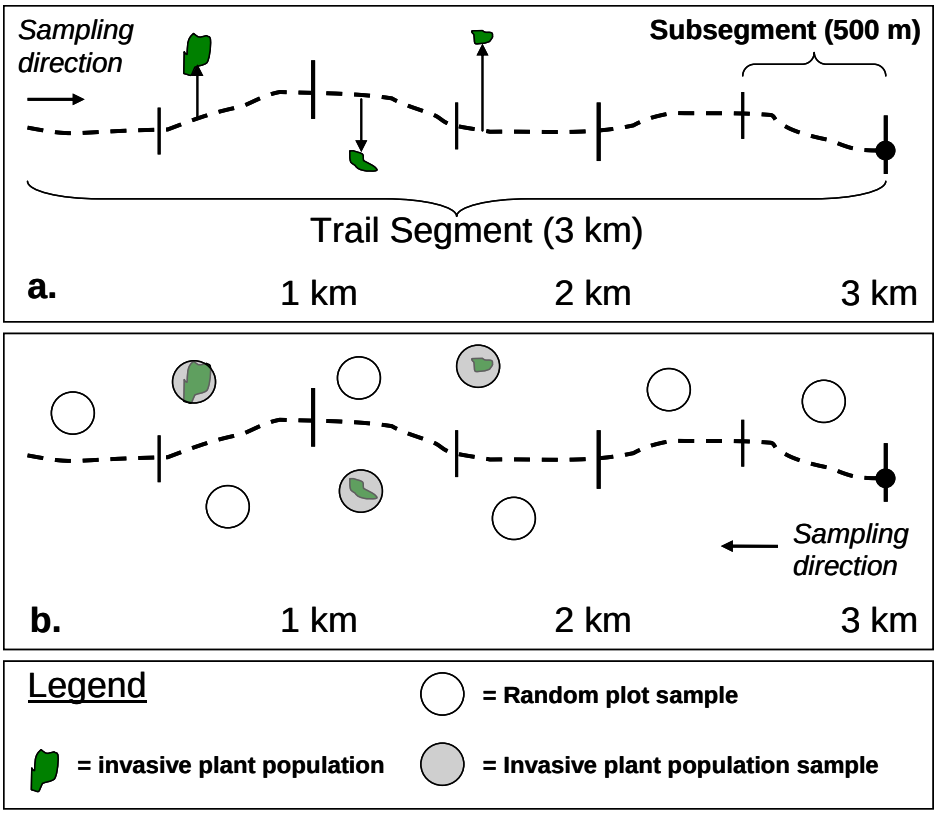

Figure 1. Schematic of segment sampling methodology for the Invasive Species Early Detection protocol. The top portion (a) shows the segment before sampling. The lower portion (b) shows the placement of plots along the segment, see legend for description of plot type.

Table 1. Invasive Species Early Detection plot measurements.

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

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 2015 season), we would have used a Garmin 62st Global Positioning System for location coordinates.

Results

2015 Accomplishments

The Klamath I&M program conducted the fourth season of its Invasive Species Early Detection Protocol from April to August 2015. 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 2015 season the crew visited 168 road and trail segments for a total of 309 km. Total segments per park are as follows: 27 in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. Roads accounted for 46% of surveyed segments while trails were 54%. 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 325 separate infestations (244 occurring as infestation plots and 81 occurring as random plots) of twenty-six invasive species. Table 2 shows number of prioritized species for each park and percentage of segments infested at each park. Table 3 shows the prioritized species observed and the percentage of segments infested by each species at the parks.

Table 2. Total number of 2015 prioritized species per park and percentage of park segments infested with the park's prioritized list of invasive species in the Klamath Network in 2015.

Park Code	Total # of species on 2015 prioritized list	% of segments infested
RNSP	40	78
LABE	17	46
ORCA	6	18
LAVO	30	12
CRLA	26	7
WHIS	40	6

Table 3. Prioritized invasive species observed in the Klamath Parks and the percentage of segments infested in the park in 2015. 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 2015. See the park-specific appendices for a full list of prioritized invasive species.

Species	Crater Lake	Lava Beds	Lassen	Oregon Caves	Redwood	Whiskeytown
Bromus tectorum (Cheatgrass)	0	--	0	9	--	0
Centaurea diffusa (Diffuse Knapweed)	0	--	0	--	--	3
Centaurea maculosa (Spotted Knapweed)	0	--	0	--	0	3
Cirsium arvense (Canada Thistle)	0	0	0	--	3	0
Cirsium vulgare (Bull Thistle)	0	0	12	0	27	0
Cortaderia spp. (Pampas Grass)	--	--	--	--	3	--
Cotoneaster spp. (Cotoneaster)	--	--	--	--	11	0
Cytisus scoparius (Scotch Broom)	0	--	0	--	22	0
Dactylis glomerata (Orchard Grass)	0	--	--	9	--	--
Descurainia sophia (Pinnate Tansymustard)	--	11	--	--	--	--
Digitalis purpurea (Fox glove)	--	--	--	--	27	--
Dipsacus fullonum (Wild Teasel)	--	--	--	--	11	--
Festuca arundinacea (Tall Fescue)	0	--	--	9	0	0
Foeniculum vulgare (Fennel)	--	--	--	--	5	0
Holcus lanatus (Velvet Grass)	0	--	0	9	--	--
Hypericum perforatum (Klamath Weed)	7	--	--	0	11	0
Melilotus spp. (Sweetclover)	0	17	--	--	--	--
Phalaris aquatica (Harding Grass)	--	--	--	--	3	--
Phalaris arundinacea (Reed Canary Grass)	--	--	0	--	11	--
Rubus armeniacus (Armenian Blackberry)	--	--	0	--	78	0
Rubus laciniatus (Cut Leaved Blackberry)	--	--	--	--	5	--
Salsola tragus (Russian Thistle)	--	20	--	--	--	--
Senecio jacobaea (Tansy Ragwort)	--	--	--	--	3	--
Spartium junceum (Spanish Broom)	--	--	--	--	--	3
Tragopogon dubius (Goatsbeard)	0	17	0	--	--	--
Verbascum thapsus (Common Mullein)	0	3	4	--	0	0

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 2015 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 2015 Accomplishments

The Klamath I&M program conducted the fourth season of its Invasive Species Early Detection Protocol from April to August 2015. 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 2015 season the crew visited 168 road and trail segments for a total of 309 km. Total segments per park are as follows: 27 in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. Roads accounted for 46% of surveyed segments while trails were 54%. Not only did the crew accomplish our annual target, they also surveyed many of the over sample segments in parks.

Park-specific Findings

CRLA was sampled between July 27 and August 16 with an intervening period at LAVO, the height of the flowering season for most invasive species, and 27 segments of 68km combined roads and trails were surveyed. The CRLA effort recorded 1 of the 26 prioritized early detection invasive species across the park (Table A.1 and Figure A.1). The species observed was Klamath Weed (*Hypericum perforatum*). Table A.2 shows the list of prioritized species searched for in 2015. Changes for the 2015 season were to include *Rumex acetosella* and *Traxacum officinale* as prioritized species.

Table A.1. Summary of prioritized invasive species found at CRLA in 2015, including infestations as a percentage of total segments surveyed at the park.

Species	Total # of infestations	# of segments infested	% of segments infested
Hypericum perforatum	2	2	7.4

Table A.2. Prioritized species for Crater Lake during the 2015 season.

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

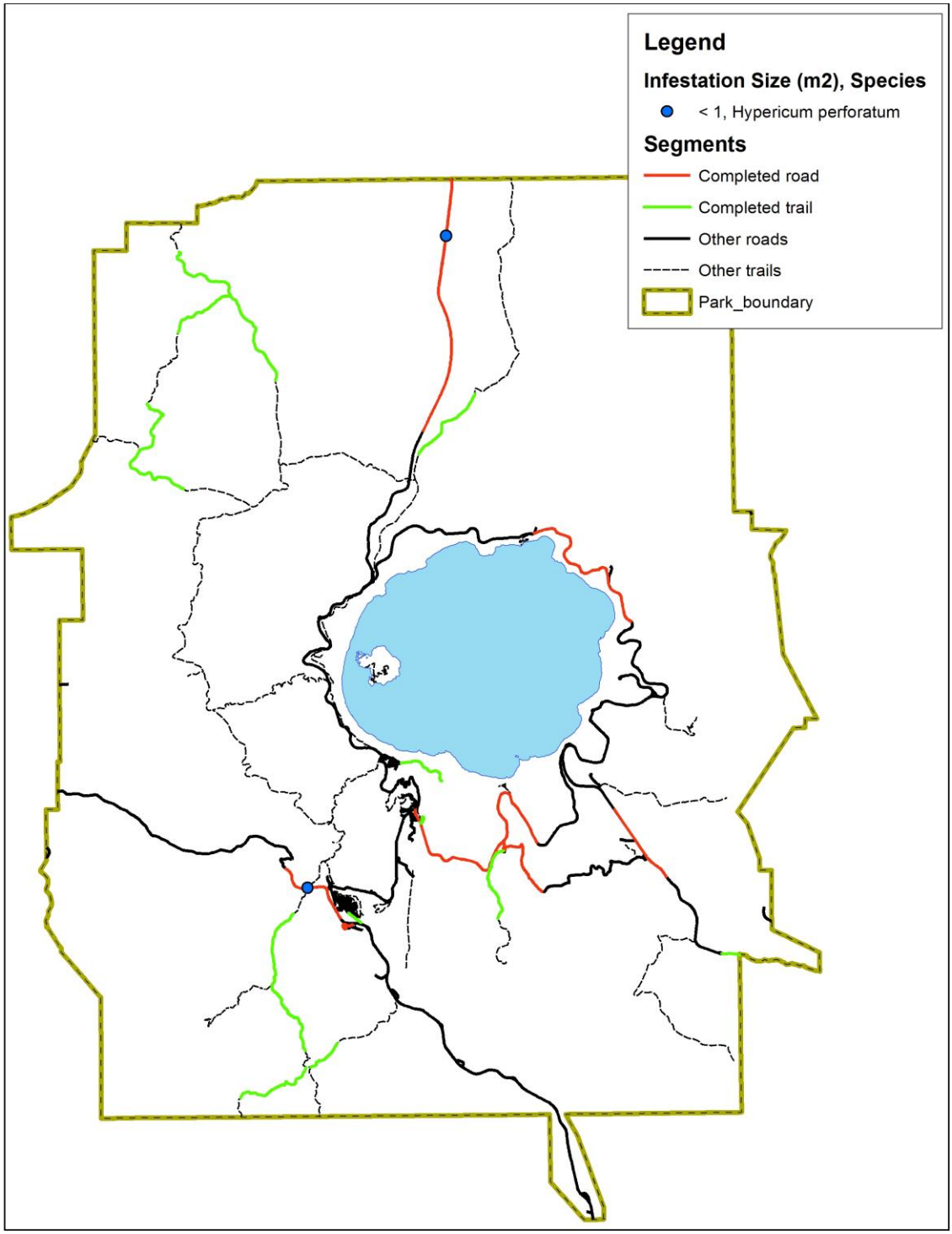

Figure A.1. Locations of invasive plant species recorded from Crater Lake NP in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year.

Appendix B: Lassen Volcanic National Park

Fiscal Year 2015 Accomplishments

The Klamath I&M program conducted the fourth season of its Invasive Species Early Detection Protocol from April to August 2015. During the season, the crew visited all 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 2015 season the crew visited 168 road and trail segments for a total of 309 km. Total segments per park are as follows: 27 in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. Roads accounted for 46% of surveyed segments while trails were 54%. Not only did the crew accomplish our annual target, they also surveyed many of the over sample segments in parks.

Park-specific Findings

LAVO was sampled between July 13 and August 12 with an intervening period at CRLA, the height of the flowering season for most invasive species, and 26 segments of 50km combined roads and trails were surveyed. The LAVO effort recorded 2 of the 30 prioritized early detection invasive species across the park (Table B.1 and Figure B.1). The species were Bull Thistle (*Cirsium vulagre*) and Common Mullein (*Verbascum thapsus*).Table B.2 shows the list of prioritized species searched for in 2015.

Table B.1. Summary of prioritized invasive species found at LAVO in 2015, including infestations as a percentage of total segments surveyed at the park.

Species	Total # of infestations	# of segments infested	% of segments infested
Cirsium vulagre	3	3	11.5
Verbascum thapsus	1	1	3.8

Table B.2. Prioritized species for Lassen Volcanic during the 2015 season.

Species	Species	Species
Acroptilon repens	*Cirsium arvense*	*Linaria genistifolia* ssp. *dalmatica*
Bromus tectorum	*Cirsium vulgare*	*Lythrum salicaria*
Cardaria draba	*Cytisus scoparius*	*Onopordum acanthium*
Carduus nutans	*Euphorbia esula*	*Phalaris arundinacea*
Carduus pycnocephalus	*Genista monspessulana*	*Phleum pratense*
Centaurea diffusa	*Halogeton glomeratus*	*Poa bulbosa*
Centaurea maculosa	*Hirschfeldia incana*	*Rubus armeniacus*
Centaurea solstitialis	*Holcus lanatus*	*Taeniatherum caput-medusae*
Centaurea virgata	*Isatis tinctoria*	*Tragopogon dubius*
Chondrilla juncea	*Lepidium latifolium*	*Verbascum thapsus*

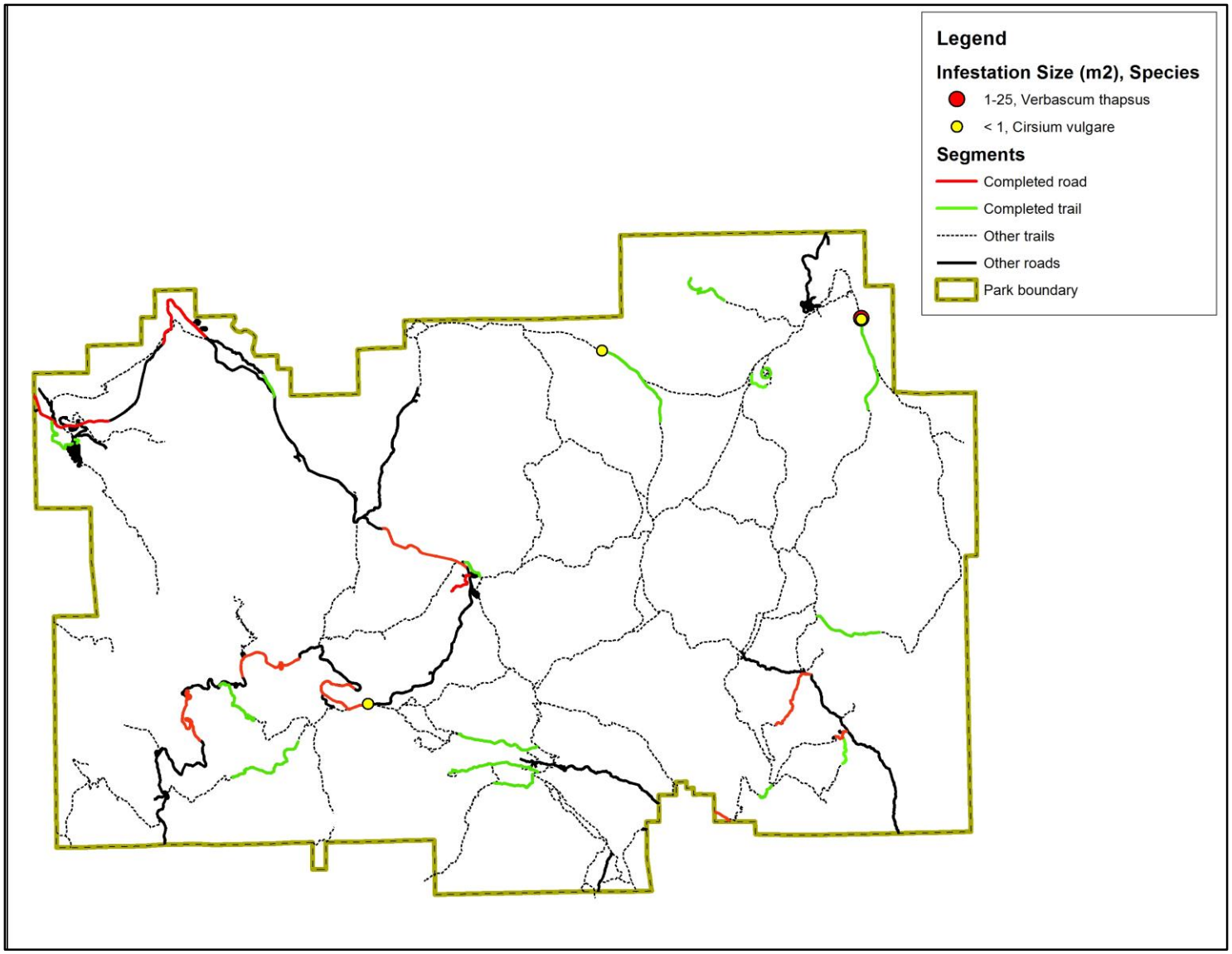

Figure B.1. Locations of invasive plant species recorded from Lassen Volcanic NP in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year

Appendix C: Lava Beds National Monument

Fiscal Year 2015 Accomplishments

The Klamath I&M program conducted the fourth season of its Invasive Species Early Detection Protocol from April to August 2015. 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 2015 season the crew visited 168 road and trail segments for a total of 309 km. Total segments per park are as follows: 27 in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. Roads accounted for 46% of surveyed segments while trails were 54%. Not only did the crew accomplish our annual target, they also surveyed many of the over sample segments in parks.

Park-specific Findings

Lava Beds was sampled between May 19 and June 4, the height of the flowering season for most invasive species, and 35 segments, or 67.9km of combined roads and trails were surveyed. The Lava Beds effort recorded five 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: Russian Thistle (*Salsola tragus*), Goatsbeard (*Tragopgon dubius*), Sweetclover (*Melilotus spp.*), Flix Weed (*Descurania* Sophia), and Common Mullein (*Verbascum thapsus*). Table C.2 shows the list of prioritized species searched for in 2015.

Table C.1. Summary of prioritized invasive species found at LABE in 2015, including infestations as a percentage of total segments surveyed at the park. Note an * indicates species only surveyed in wilderness areas.

Species	Total # of infestations	# of segments infested	% of segments infested
Salsola tragus	47	7	20
*Tragopogon dubius**	18	6	17
Melilotus spp.	13	6	17
*Descurainia sophia**	31	4	11
*Verbascum thapsus**	1	1	2.8

Table C.2. Prioritized species for Lava Beds during the 2015 season.

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

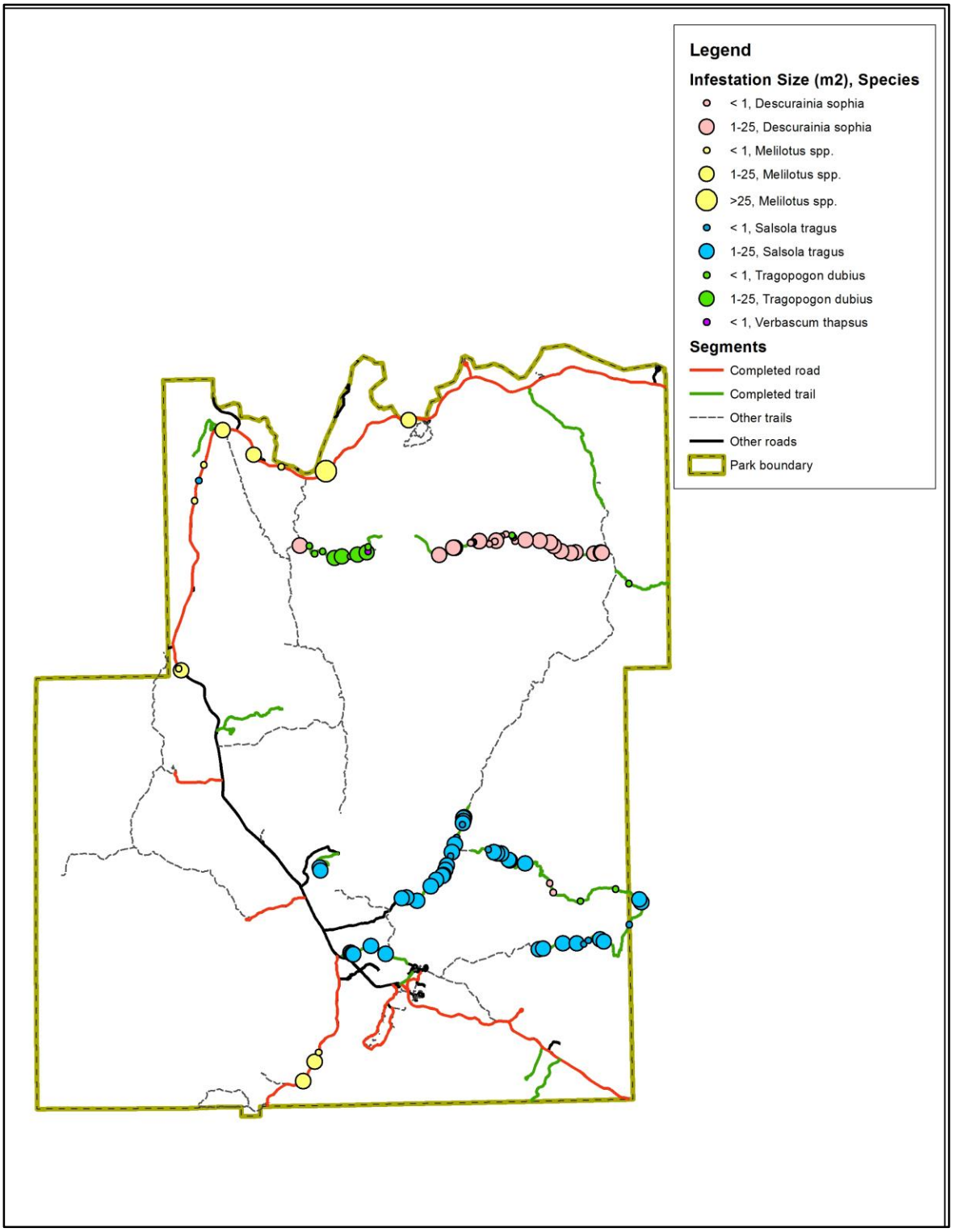

Figure C.1. Locations of invasive plant species recorded from Lava Beds NM in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year.

Appendix D: Oregon Caves National Monument and Preserve

Fiscal Year 2015 Accomplishments

The Klamath I&M program conducted the fourth season of its Invasive Species Early Detection Protocol from April to August 2015. 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 2015 season the crew visited 168 road and trail segments for a total of 309 km. Total segments per park are as follows: 27 in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. Roads accounted for 46% of surveyed segments while trails were 54%. Not only did the crew accomplish our annual target, they also surveyed many of the over sample segments in parks.

Park-specific Findings

Oregon Caves was sampled between June 6 and June 7, 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 four of the six prioritized early detection invasive species across the park (Table D.1 and Figure D.1): Orchardgrass (*Dactylis glomerata*) Tall Fescue (*Festuca arundacea*), Cheatgrass (*Bromus tectorum*), and Velvet Grass (*Holcus lanatus*). Table D.2 shows the list of prioritized species searched for in 2015.

Table D.1. Summary of prioritized invasive species found at ORCA in 2015, including infestations as a percentage of total segments surveyed at the park.

Species	Total # of infestations	# of segments infested	% of segments infested
Bromus tectorum	1	1	9
Dactylis glomerata	2	1	9
Festuca aruninacea	2	1	9
Holcus lanatus	1	1	9

Table D.2. Prioritized species for Oregon Caves during the 2015 season.

Species
Bromus tectorum
Cirsium vulgare
Dactylis glomerata
Festuca arundinacea
Holcus lanatus
Hypericum perforatum

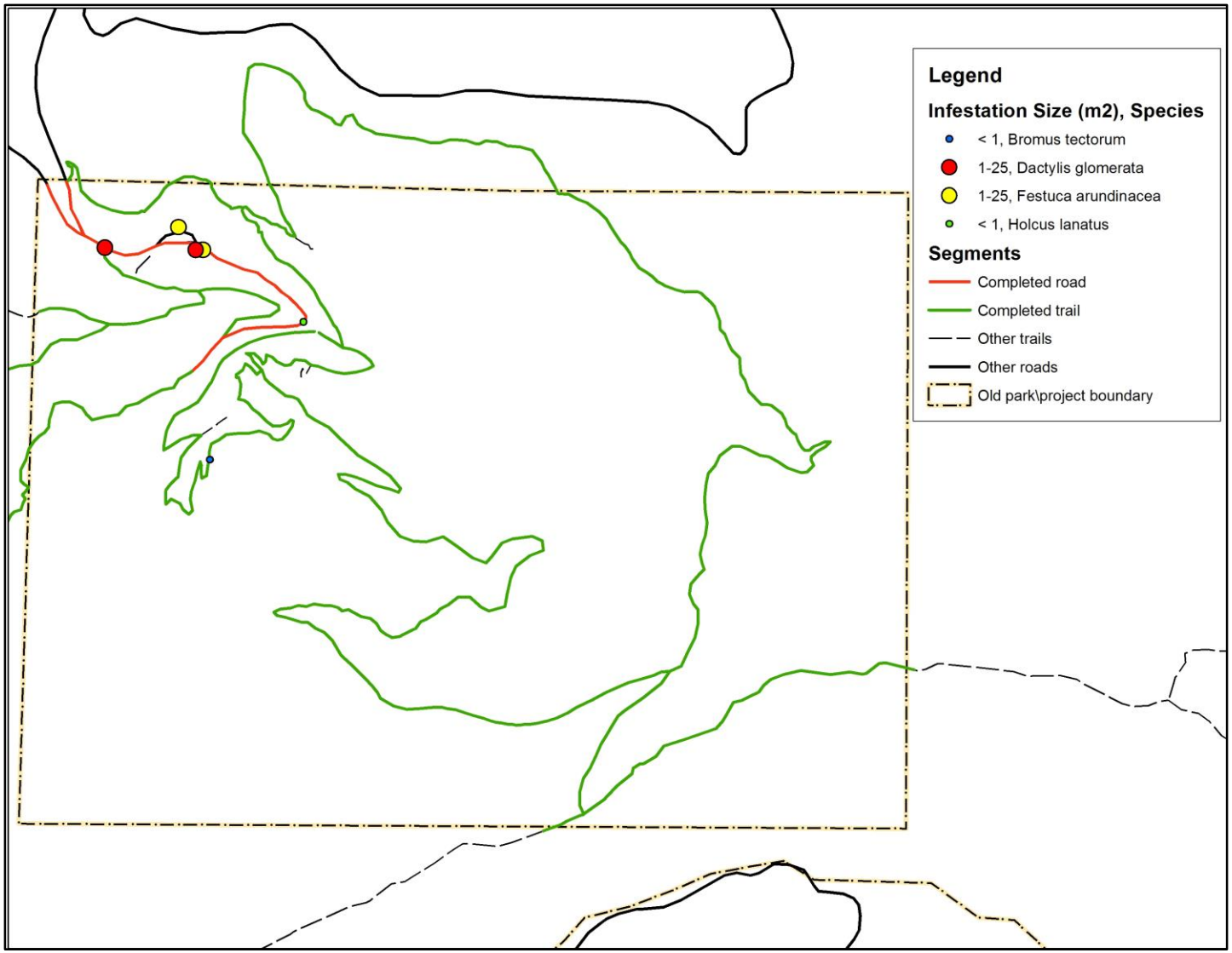

Figure D.1. Locations of invasive plant species recorded from Oregon Caves NMP in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year.

Appendix E: Redwood National and State Parks

Fiscal Year 2015 Accomplishments

The Klamath I&M program conducted the fourth season of its Invasive Species Early Detection Protocol from April to August 2015. 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 2015 season the crew visited 168 road and trail segments for a total of 309 km. Total segments per park are as follows: 27 in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. Roads accounted for 46% of surveyed segments while trails were 54%. Not only did the crew accomplish our annual target, they also surveyed many of the over sample segments in parks.

Park-specific Findings

RNSP was sampled between June 16 and July 6, the height of the flowering season for most invasive species, and 37 segments of 61 km combined roads and trails were surveyed. The RNSP effort recorded 14 of the 40 prioritized early detection invasive species across the park (Table E.1 and Figure E.1, E.2, and E.3). The species, in descending order of abundance, included: Armenian Blackberry (*Rubus armeniacus*), Digitalis (*Digitalis pupurea*), Bull Thistle (*Cirsium vulgare*), Scotch Broom (*Cystisus scoparius*), Canary Reed Grass (*Phalaris arundinacea*), Wild Teasel (*Dispacus fullonum*), Cotoneaster (*Cotoneaster* spp.), St. John's Wort (*Hypericum perforatum*), Cut Leaved Blackberry (*Rubus lanciniatus*)Fennel (*Foeniculum vulgare*), `Tansy Ragwort (*Senecio jacobea*), Canada Thistle (*Cirsium arvense*), Pampas Grass (*Cortaderia* spp.), and Harding Grass (*Phalaris aquatica*). Table E.2 shows the list of prioritized species searched for in 2015. At the request of the park we added *Geranium lucidum* to the prioritized list for 2015. Also, at the request of the park, we limited the scope of the sampling frame.

Table E.1. Summary of prioritized invasive species found at RNSP in 2015, including infestations as a percentage of total segments surveyed at the park

Species	Total # of infestations	# of segments infested	% of segments infested
Rubus armeniacus	89	29	78
Digitalis pupurea	28	10	27
Cirsium vulgare	13	10	27
Cytisus scoparius	18	8	22
Phalaris arundinacea	19	4	11
Dipsacus fullonum	10	4	11
Cotoneaster spp.	6	4	11
Hypericum perforatum	4	4	11
Rubus laciniatus	4	2	5
Foeniculum vulgare	5	2	5
Senecio jacobea	1	1	3
Phalaris aquatic	1	1	3

Table E.1 (continued). Summary of prioritized invasive species found at RNSP in 2015, including infestations as a percentage of total segments surveyed at the park

Species	Total # of infestations	# of segments infested	% of segments infested
Cortadaria spp.	1	1	3
Cirsium arvense	1	1	3

Table E.2. Prioritized species for Redwood during the 2015 season.

Species	Species	Species
Acacia dealbata	*Erica lusitanica*	*Polygonum* spp.
Allium triquetrum	*Festuca arundinacea*	*Prunus avium*
Carpobrotus chilensis	*Foeniculum vulgare*	*Robinia pseudoacacia*
Centaurea maculosa	*Genista monspessulana*	*Rubus armeniacus*
Centaurea solstitialis	*Geranium lucidum*	*Rubus laciniatus*
Cirsium arvense	*Geranium robertianum*	*Senecio jacobaea*
Cirsium vulgare	*Hedera helix*	*Silybum marianum*
Cortaderia spp.	*Hypericum perforatum*	*Ulex europaeus*
Cotoneaster spp.	*Ilex aquifolium*	*Verbascum thapsus*
Crataegus monogyna	*Linaria genistifolia ssp. dalmatica*	*Vinca major*
Cytisus scoparius	*Lupinus arboreus*	
Delairea odorata	*Phalaris aquatica*	
Digitalis purpurea	*Phalaris arundinacea*	
Dipsacus fullonum	*Pinus radiata*	

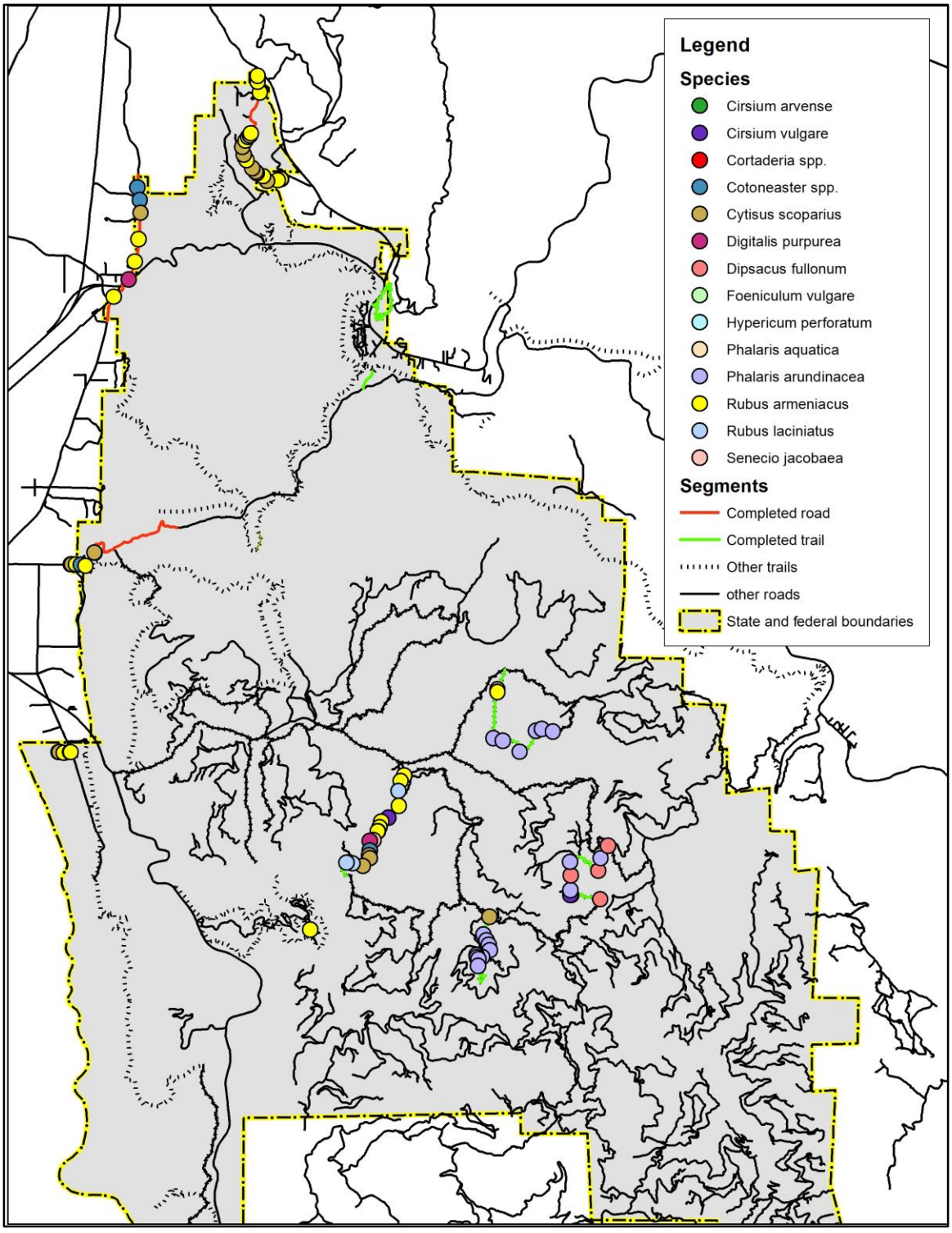

Figure E.1. Locations of invasive plant species recorded from Redwood NSP in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year. Portions of the park not shown, lack visited segments.

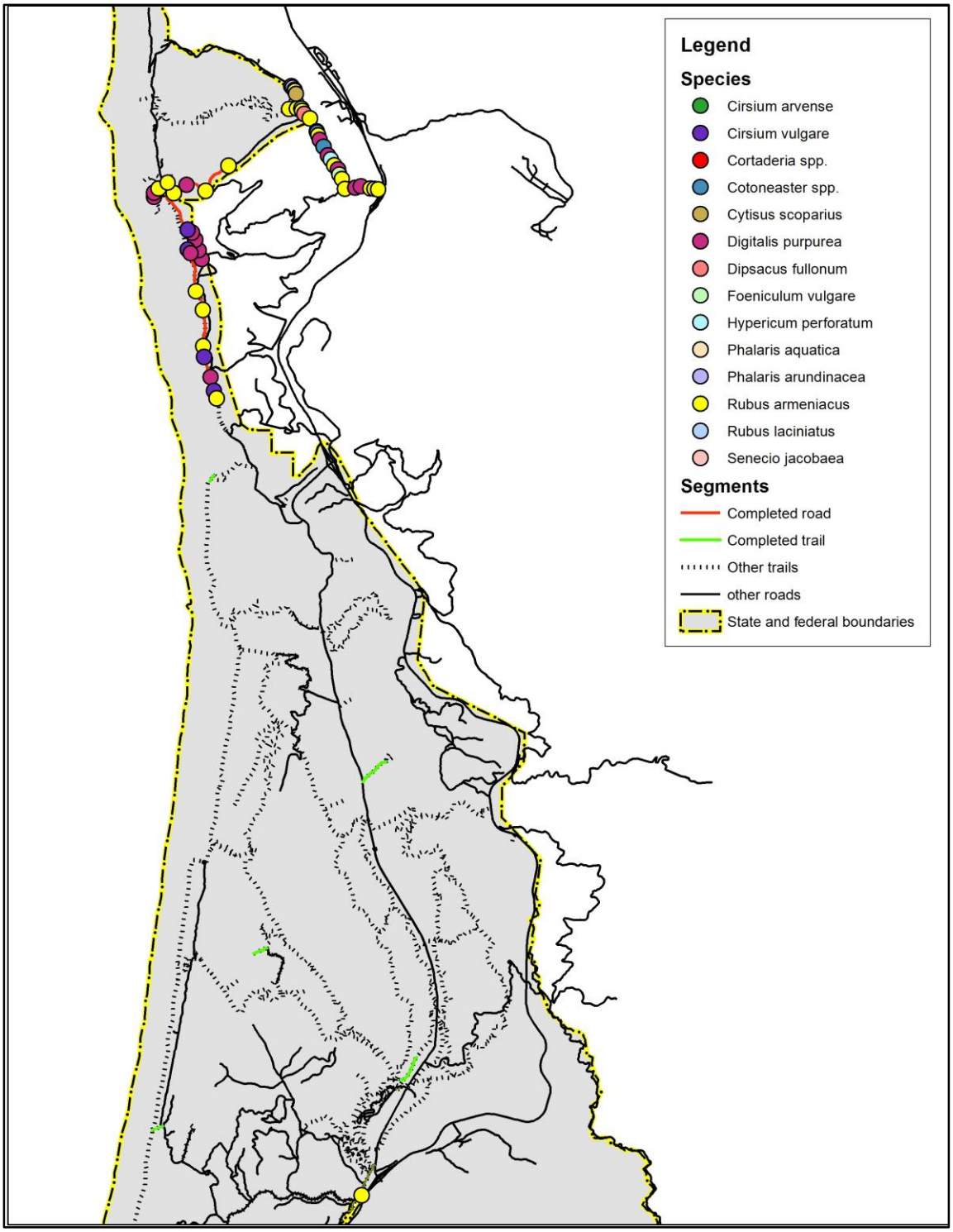

Figure E.2. Locations of invasive plant species recorded from Redwood NSP in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year. Portions of the park not shown, lack visited segments.

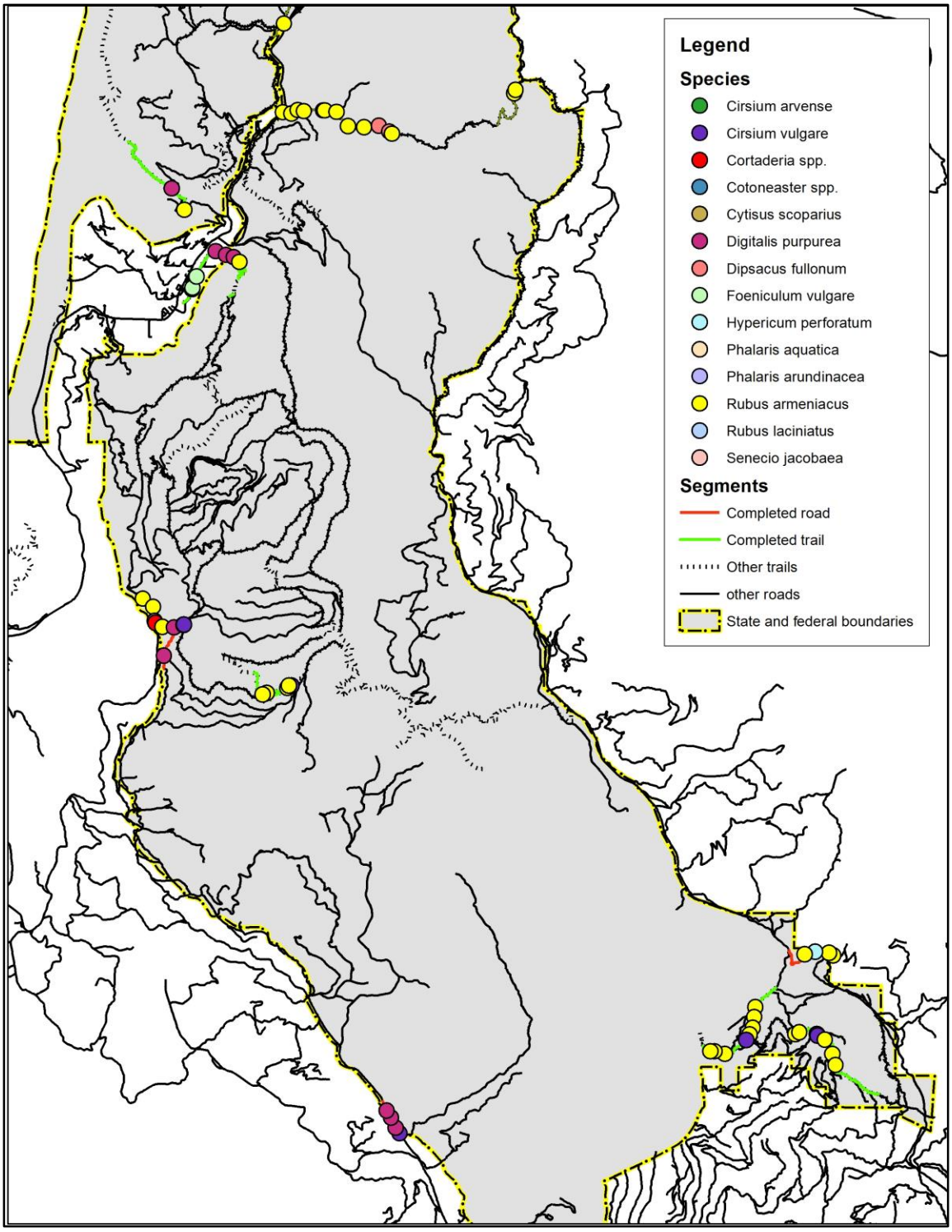

Figure E.3. Locations of invasive plant species recorded from Redwood NSP in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year. Portions of the park not shown, lack visited segments.

Appendix F: Whiskeytown National Recreation Area

Fiscal Year 2015 Accomplishments

The Klamath I&M program conducted the fourth season of its Invasive Species Early Detection Protocol from April to August 2015. 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 2015 season the crew visited 168 road and trail segments for a total of 309 km. Total segments per park are as follows: 27 in CRLA, 26 in LAVO, 35 in LABE, 11 in ORCA, 37 in RNSP, and 32 in WHIS. Roads accounted for 46% of surveyed segments while trails were 54%. Not only did the crew accomplish our annual target, they also surveyed many of the over sample segments in parks.

Park-specific Findings

Whiskeytown was sampled between April 28 and May 9, and 32 segments, or 50.0 km of combined roads and trails were surveyed. The Whiskeytown effort recorded three of the 40 prioritized early detection invasive species across the park (Table F.1 and Figure F.1). The species, in decreasing order of abundance, included: Spanish Broom (*Spartium junceum*), Diffuse Knapweed (*Centaurea diffusa*), and Spotted Knapweed (*Centaurea maculosa*). Table F.2 shows the list of prioritized species searched for in 2015.

Table F.1. Summary of prioritized invasive species found at WHIS in 2015, including infestations as a percentage of total segments surveyed at the park

Species	Total # of infestations	# of segment infestations	% of segments infested
Centaurea diffusa	1	1	3.1
*Centaurea maculosa**	1	1	3.1
Spartium junceum	1	1	3.1

Table F.2. Prioritized species for Whiskeytown during the 2015 season.

Species	Species	Species
Aegilops triuncialis	*Cirsium vulgare*	*Linaria genistifolia* ssp. *dalmatica*
Ailanthus altissima	*Cotoneaster pannosa*	*Lythrum salicaria*
Anthoxanthum odoratum	*Cynaria cardunculus*	*Poa pratensis*
Arundo donax	*Cynodon dactylon*	*Rubus armeniacus*
Brassica tournefortii	*Cytisus scoparius*	*Rumex acetosella*
Bromus diandrus	*Delairea odorata*	*Sesbania exaltata*
Bromus hordeaceus	*Euphorbia esula*	*Spartium junceum*
Bromus rubens	*Festuca arundinacea*	*Tamarix* spp.
Bromus tectorum	*Foeniculum vulgare*	*Torilis arvensis*
Centaurea diffusa	*Genista monspesullana*	*Ulex europaeus*

Table F.2 (continued). Prioritized species for Whiskeytown during the 2015 season.

Species	Species	Species
Centaurea maculosa	*Hypericum perforatum*	*Verbascum blattaria*
Centaurea melitensis	*Isatis tinctoria*	*Verbascum thapsus*
Centaurea solstitialis	*Lepidium latifolium*	
Cirsium arvense	*Leucanthemum vulgare*	

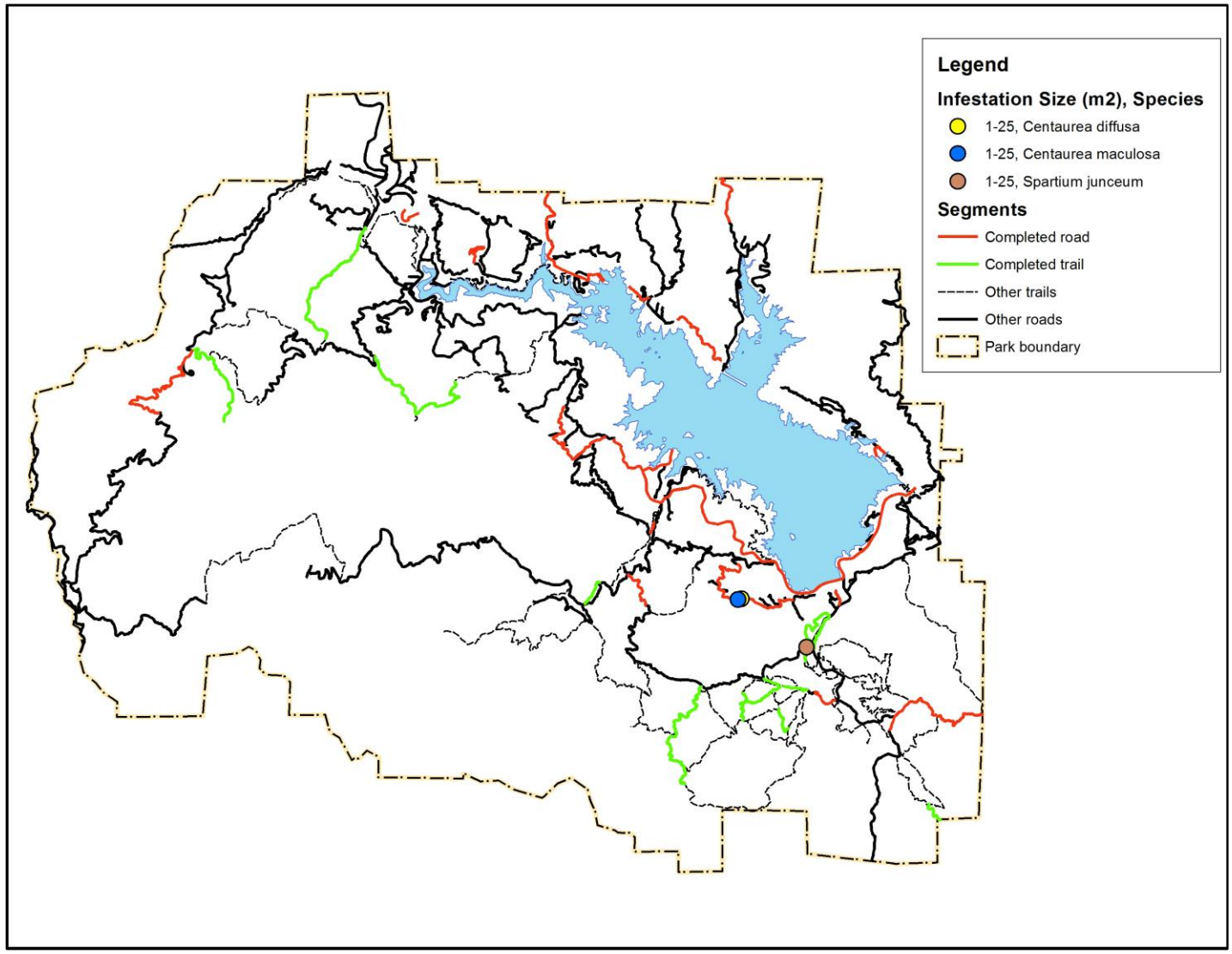

Figure F.1. Locations of invasive plant species recorded from Whiskeytown NRA in the 2015 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year, roads and trails in black were not sampled for this fiscal year

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