



Klamath Network Invasive Species Early Detection Monitoring Protocol Annual Report for the 2011 Field Season

Natural Resource Technical Report NPS/KLMN/NRTR—2014/847



ON THE COVER

Common mullein (*Verbascum thapsus*), one of the Klamath Network's prioritized invasive species, shown here at Lava Beds National Monument.

Photograph by: Sean B. Smith, Klamath Network Inventory and Monitoring Program

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Natural Resource Technical Report NPS/KLMN/NRTR—2014/847

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Executive Summary

The Klamath Inventory and Monitoring program implemented its Invasive Species Early Detection Protocol from April to September 2011. This was the second time the protocol has been implemented using a repeatable, peer-reviewed methodology at comparable intensities. During the field season, a two person crew visited all six parks in the Klamath Network, beginning in Whiskeytown National Recreation Area and concluding in Redwood National and State Park. The crew monitored 146 road and trail segments, covering a total of 350 km. The sample effort matched or exceeded our goals. We observed a total of 217 separate infestations of 26 priority invasive species, and collected site-specific data at 161 of these infestations. Invasive species infestations tended to occur within 6 m of a road or trail, in areas with less overstory cover, and more often along roads than trails.

Introduction

In the late spring 2011, the Klamath Network Inventory and Monitoring (I&M) Program implemented its Invasive Species Early Detection Monitoring (ISED) Protocol at all six Network parks: Crater Lake National Park (CRLA), Lava Beds National Monument (LBE), Lassen Volcanic National Park (LAVO), Oregon Caves National Monument (ORCA), Redwood National and State Parks (REDW), and Whiskeytown National Recreation Area (WHIS). Results of the 2011 season are described here in the annual report format that the Network proposes to employ in future monitoring years. These annual reports are intended to 1) quickly summarize the work completed in a given field season and 2) assist park managers with targeting their rapid invasive species response efforts. We welcome feedback on the format and content of the report to help ensure future reports are optimized for usefulness to managers.

Methods

Field Preparation

Site Selection

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). We chose the number of segments to be visited at each park based on criteria explained in the Klamath Network ISED Protocol (Odion et al. 2010). We set the minimal sample size (segments visited) for WHIS, CRLA, LAVO, and LBE at 25. Redwood, having the largest mileage of roads and trails, had a minimal sample size of 35 segments. Oregon Caves, due to its small size, had a complete census of all road and trail segments performed: ten total.

Species Selection

Klinger and Brooks (2008) conducted the invasive species prioritization to select species to monitor on a park-by-park basis. They used a combination of expert opinion and peer reviewed publications. First, lists of non-native species were split into two categories: invasive and non-invasive. Non-invasive species were judged to not be ecosystem transformers 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, 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). Before the beginning of the 2011 season, minor

modifications occurred to the prioritization lists at CRLA, LABE, and WHIS based on expert new knowledge of park invaders.

Field Methods

Site Sampling

The field crew traversed each 3 km target segment, starting at the most accessible end. Locations and the size category of each infestation (<1 m², 1-25 m², or >25 m²) were recorded on a Geographic Positioning System. 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), up to three infestations plots per segment were sampled. Plots were circular, 100 m², centered on the infestation, randomized and spatially balanced among infestations when these were numerous. Crews also randomly placed one circular 100 m² plot within 6-14 m of the road or trail in each 500 m subsegment, without regard to location of infestations (Figure 1.). In each of these random plots, we sampled the vegetation and environmental variables and abundance of invasive species (if present) (Table 1). Canopy cover was measured with a spherical densitometer.

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.

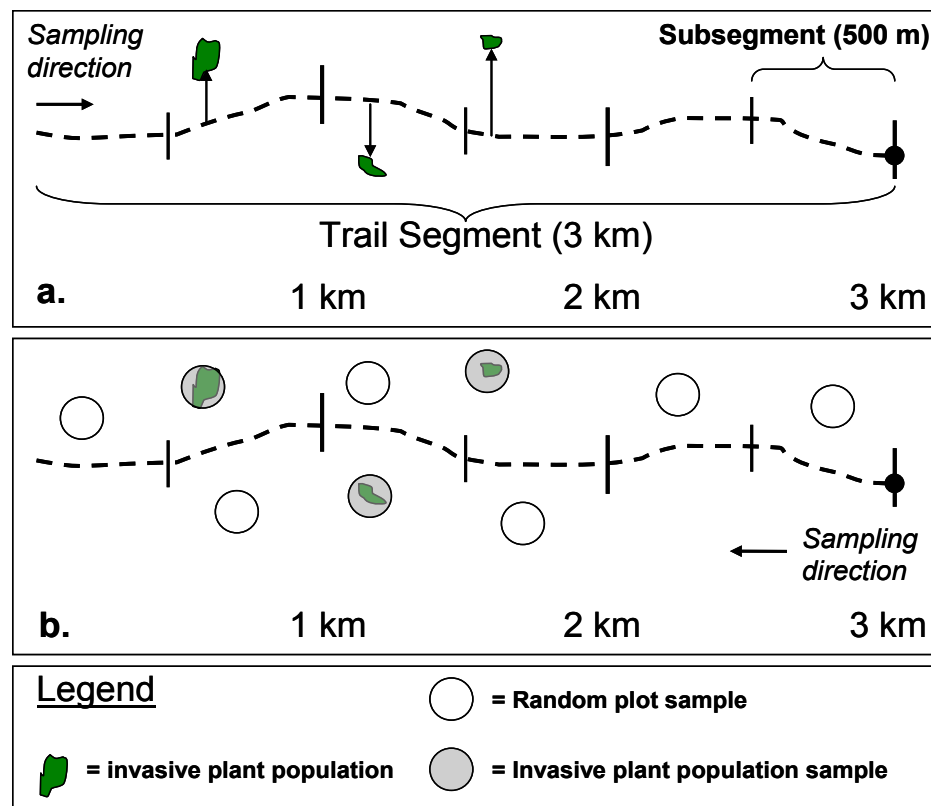


Figure 1. Schematic of segment sampling methodology for the Invasive Species Early Detection protocol.

Table 1. ISED 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
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Data Collection

We recorded data electronically with a Trimble GeoXM handheld GPS. This was also the primary source of geographical data. In cases where the Trimble could not get satellite reception, we used a Garmin 76CSX or Garmin GPSmap 78s Global Positioning System for location coordinates. Data were also recorded at plots using paper datasheets when the Trimble was unable to record data. In addition, a photo was taken at the beginning and end of each segment using a Nikon Coolpix 2500 digital camera; photometadata were recorded using paper datasheets.

Statistical Analyses

We employed chi-square analyses of counts of infestations to test the null hypothesis that there was no difference in the occurrence of infestations between roads and trails.

Results

Crew Productivity

We monitored 146 road and trail segments for a total of 350 km. Roads accounted for 53.4% of surveyed segments while trails were 47.6%. We averaged 2.3 segments per day. The largest number of segments completed in one day was six. Some minor inconsistencies with GIS coverages or poor GPS reception slowed our productivity. Some selected segments/subsegments could not be done for a variety of reasons (see park specific findings). These undoable segments or subsegments may be removed from the sampling frame used in future sampling. When a segment could not be completed it was replaced with another segment from our GRTS draw.

General Patterns of Invasive Species Distribution and Abundance

We observed a total of 217 separate infestations of 26 invasive species (Table 2) and collected site-specific data at 161 of these infestations. Five invasive species occurred in six of 725 random plots. The most common plant family represented among infestations was Asteraceae with eight species followed by Fabaceae and Poaceae each with 4. Fourteen observed species were herbaceous perennials, eight were annuals/biennial, and four were woody trees or shrubs.

The majority of invasive species infestations (95%) observed occurred within 6 m of a road or trail (Figure 2). The species occurring over 6 m from a road or trail were Scotch broom (*Cytisus scoparius*), tree of heaven (*Ailanthus altissima*), pinnate tansy mustard (*Descurainia sophia*), foxglove (*Digitalis purpurea*), bull thistle (*Cirsium vulgare*), and star thistle (*Centaurea sosterialis*). The longest distance any species (tree of heaven) was observed from a road or trail was 15 m.

Infestations occurred more commonly along roads (53.5%) than along trails (46.5%). However, this difference was not significant ($\chi^2 = 1.04$ on 1 degrees of freedom; $p = >0.1$).

Eighty three percent of infestations occurred at or below 1500 m elevation (Figure 3). The average elevation of infestations was 915 m, the lowest was 2 m, and the highest 2017 m.

Invasive species tended to be more common in areas with less overstory cover (Figure 4). Four species, Asian mustard (*Brassica tournefortii*), cheatgrass (*Bromus tectorum*), Canada thistle (*Cirsium arvense*), and sweetclover (*Melilotus* spp.) had an average overstory cover as estimated using the spherical densitometer, of $< 1\%$. Four species occurred in plots where the average densitometer readings were above 50%: bull thistle (*Cirsium vulgare*), tall fescue (*Festuca arundinacea*), cut-leaved blackberry (*Rubus laciniatus*), and English ivy (*Hedera helix*). Infestations along roads had lower average canopy cover than trails, 28 and 42% respectively.

Table 2. Prioritized invasive species observed in the Klamath Parks, 2011. Note: not all parks have the same species prioritized, See Appendices. Crater Lake National Park (CRLA), Lava Beds National Monument (LBE), Lassen Volcanic National Park (LAVO), Oregon Caves National Monument (ORCA), Redwood National and State Parks (REDW), and Whiskeytown National Recreation Area (WHIS).

Species	Total Frequency %	Parks
goat's beard (<i>Tragopogon dubius</i>)	15.6	CRLA(0.5), LBE(13.7), LAVO(1.4)
pinnate tansy mustard (<i>Descurainia sophia</i>)	14.7	LBE(14.7)
Scotch broom (<i>Cytisus scoparius</i>)	14.2	RNSP(8.5), WHIS(5.7)
bull thistle (<i>Cirsium vulgare</i>)	7.9	LBE(.9), LAVO(3.3), RNSP(2.8), WHIS(0.9)
Klamath weed (<i>Hypericum perforatum</i>)	6.2	CRLA(3.8), ORCA(2.4)
Armenian blackberry (<i>Rubus armeniacus</i>)	4.8	RNSP(4.3), WHIS(0.5)
yellow starthistle (<i>Centaurea solstitialis</i>)	4.3	WHIS(4.3)
tree of heaven (<i>Ailanthus altissima</i>)	3.3	WHIS(3.3)
nodding plumeless thistle (<i>Carduus nutans</i>)	3.3	LAVO(3.3)
sweetclover (<i>Melilotus</i> spp.)	2.8	LBE(2.8)
mullein (<i>Verbascum thapsus</i>)	2.8	WHIS(2.8)
vernal sweetgrass (<i>Anthoxanthum odoratum</i>)	2.4	WHIS(2.4)
spotted knapweed (<i>Centaurea maculosa</i>)	2.4	WHIS(2.4)
English Ivy (<i>Hedera helix</i>)	2.4	RNSP(2.4)
orchard grass (<i>Dactylis glomerata</i>)	1.9	ORCA(1.9)
sheep sorrel (<i>Rumex acetosella</i>)	1.9	CRLA(1.9)
foxglove (<i>Digitalis purpurea</i>)	1.4	RNSP(1.4)
Spanish broom (<i>Spartium junceum</i>)	1.4	WHIS(1.4)
Canada thistle (<i>Cirsium arvense</i>)	1	LBE(0.5), RNSP(0.5)
French broom (<i>Genista monspessulana</i>)	1	RNSP(0.5), WHIS(0.5)
cape ivy (<i>Delairea odorata</i>)	0.9	RNSP(0.9)
cut-leaved blackberry (<i>Rubus laciniatus</i>)	0.9	RNSP(0.9)
dandelion (<i>Taraxacum officinale</i>)	0.9	CRLA(0.9)
Asian mustard (<i>Brassica tournefortii</i>)	0.5	WHIS(0.5)
cheatgrass (<i>Bromus tectorum</i>)	0.5	ORCA(0.5)
tall fescue (<i>Festuca arundinacea</i>)	0.5	WHIS(0.5)

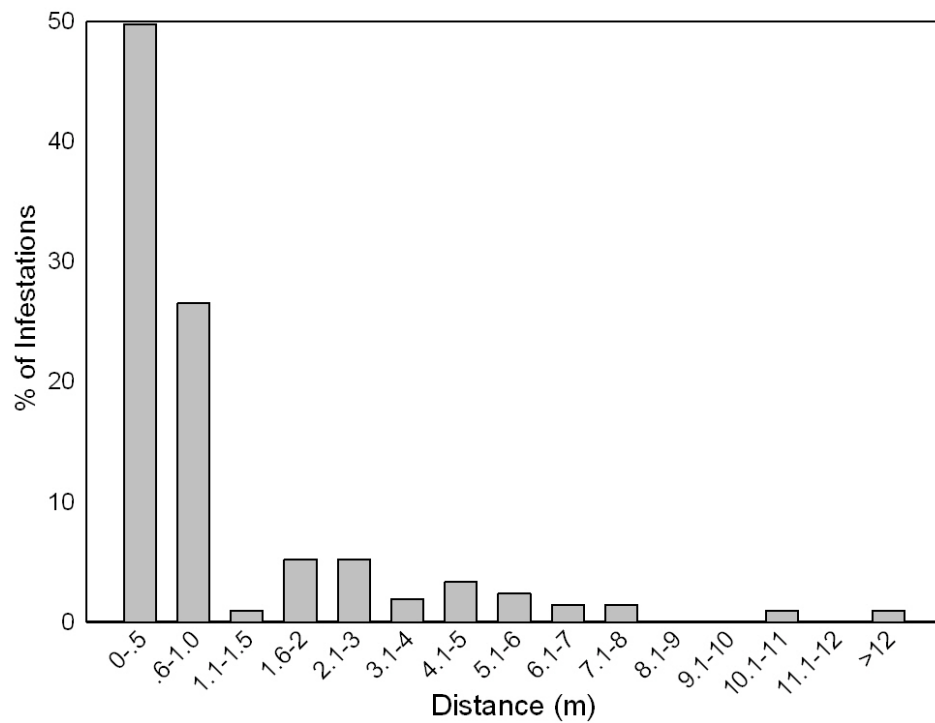


Figure 2. Percent of infestations as a function of increasing distance (m) from a road or trail in the 2011 invasive species monitoring by the Klamath Network.

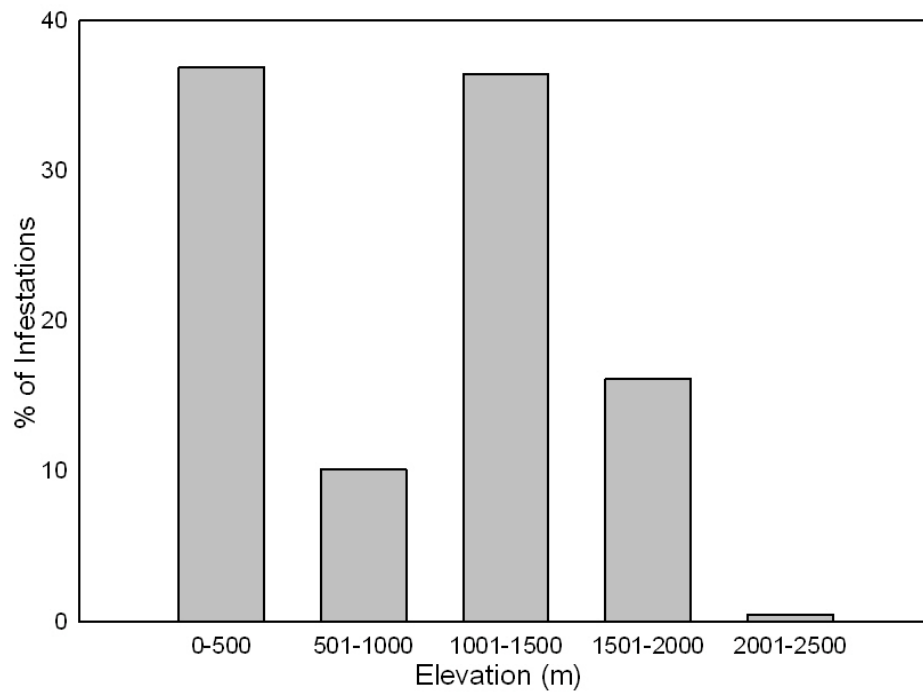


Figure 3. Percent of infestations in each elevation zone across the parks of the Klamath Network in 2011.

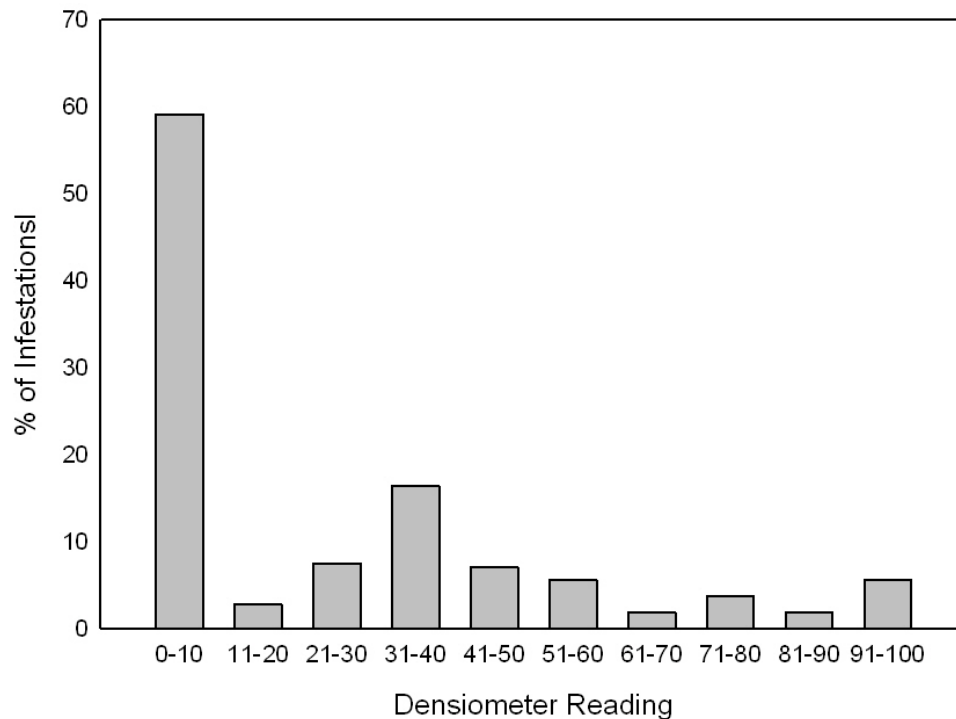


Figure 4. Percent of infestations by overstory cover class (measured with a densiometer) in all the parks of the Klamath Network.

Park-specific Patterns

Appendices A-F list important information about park specific survey dates, number and distances of segments completed, segments not completed, and species encounter along with locations and abundance maps. Discussed below are park specific patterns that differ from the Network patterns as a whole.

We encountered the highest percentage of infested segments at WHIS (Table 3) and the lowest at the two high elevation parks, CRLA and LAVO.

While the number of infected road vs. trail segments not significant at the network level; conversely, two parks did have significant differences in road and trail infestations. At LABE trails were more infested ($\chi^2 = 3.71$ on 1 degrees of freedom; $p = <0.1$) and infestations occurred more commonly along roads at CRLA ($\chi^2 = 3.14$ on 1 degrees of freedom; $p = <0.1$)

Lava Beds had the lowest average canopy cover of infestations, and is the only park where this was below the Network average (Table 4).

Table 3. Percentage of segments with invasive species infestations by park in the Klamath Network in 2011.

Park Code	% of segments infested
WHIS	68
LABE	54
ORCA	40
REDW	34
LAVO	32
CRLA	12

Table 4. Average overstory cover (measured with a densiometer) of infested plots for all parks compared to the network average (KLMN) in the Klamath Network in 2011.

Park Code	Avg. canopy cover % at Infestation
LABE	2.0
WHIS	23.7
CRLA	25.2
ORCA	33.0
RNSP	37.2
LAVO	42.8
KLMN	21.7

Discussion

Priority Species

Minor changes were made to the list of target invasive species prior to field sampling (Appendices A-F), largely to reflect changes to the invasion phase of certain species based on current information. As the floristic composition of all landscapes is constantly in flux, we expect that our prioritized lists of invasive species will need to be adjusted periodically to reflect on-the-ground conditions. We recommend that, before each monitoring season, Klamath Network personnel discuss with park personnel the proposed list of invasive species to be monitored and make adjustments as necessary. Although changes in the list will weaken comparisons across years for individual species, they will ensure that this management protocol is targeted towards the highest priority threats over time. At some point in the future, a more formal prioritization like that undertaken by Klinger and Brooks (2008) should be undertaken. This will require additional funding.

We found more infestations along roads, the main transportation corridors in the parks, than trails, but there was no significant difference. There was a significant difference in 2009. It is likely that roads are the areas of greatest propagule pressure by invasive species due to the likelihood of species being dispersed by vehicles. However, at LABE trails were significantly more infested than roads. This could be due to invasive species being relatively easy to see along roads at LABE making them more easily targeted for removal under the Monument's aggressive invasive species treatment policy. There are often different abiotic conditions along roads than trails. Roadsides often have more frequent disturbance of greater magnitude as well as greater soil resources (water, nutrients) due to lack of root competition under the road prism or due to runoff from the road surface. Roads are thought of as having less canopy cover than trails, and we observed this in 2011. It is unknown how many species will colonize along roads and then expand through the parks, given the distinctiveness of the roadside habitat. Our findings, in particular the differing patterns of invasion at the network parks, justify targeting both roads and trails as focal locations for early detection monitoring.

As in 2009, our findings suggest that invasion is strongly correlated with distance to road or trail. Likely causes of this finding are increased propagule pressure near transportation corridors and also greater resource availability. For example, water and nutrient levels are higher next to roads, as discussed above. In addition, we found that most invasives occurred in full sunlight or only minimal overstory cover. Trailsides and roadsides have greater light levels due to the opening in the vegetation canopy created by the construction of a road or trail, and this effect is greatest closer to the road or trail. We did, however, find a number of species (e.g., English ivy at RNSP) that are shade tolerant. Martin et al. (2009) point out that these shade tolerant species may be of greatest concern because they are capable of invading pristine areas even in the absence of disturbance.

We had six infestations in 725 random plots; in 2009 we had 0 infestations in random plots. The complete absence of invasive species in our 788 randomly-placed plots from 2009 was somewhat surprising. Our random plots have a radius of 5.65 m, with the center placed from 6-14 m from a road or trail. Thus with plots having the possibility of being placed in the area where infestations occur most frequently (<6 m), had there been a problem of overlooked infestations, we probably

would have encountered some in random plots in 2009. It is likely that detection of infestations is hampered by poor visibility through dense vegetation and potentially that some crew members will prove better at detecting invasive species than others. This would explain why we see more infestations nearest roads and trails. In the future, we will continue to track the number of infestations in random plots for trends, and may also want to analyze the role of detection distance and differences in crew member observations of invasive species, as is done with avifauna (Buckland et al. 2001).

At Crater Lake, our crew recorded some false negatives, as sampling followed invasive plant control efforts undertaken earlier in the season. Jen Beck, Botanist for CRLA, informed us that before we began sampling at the park, crews implemented management actions in an effort to control invasive species. This was also the case at Lassen in 2009, but with coordination we were able to visit all our prioritized segments before park control measures were implemented that season. The most important aspect of coordinated efforts is to eliminate false negatives. To that effect we know where at Crater Lake we likely missed infestations (see Crater Lake section in Appendix A). In future years we should make efforts to coordinate with all parks to survey before their control efforts have commenced.

The Klamath Network ISED Protocol, again, proved to be efficient and effective in detecting infestations of the target species. It allowed sampling of a large array of road and trail corridors in all parks of the Klamath Network. Using a two person field crew and in one field season, resulting in hundreds of georeferenced invasive plant infestations to target for control or eradication. It appears to be an important addition to park-based monitoring and control efforts, and with continued support and assistance from park managers, should aid in the protection of park resources.

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Appendix A: Crater Lake National Park

Fiscal Year 2011 Accomplishments

The Klamath I&M program implemented, for the second time, its Invasive Species Early Detection Protocol from May to September 2011. During the season, a two person crew led by Alicia Fitzgerald visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 146 road and trail segments for a total of 350 km. The sample effort matched or exceeded expectations, which was particularly heartening for the second full season of implementation.

Park-specific Findings

Crater Lake was sampled between August 30 and September 4, then again from September 12 to September 15. We surveyed 25 segments, or 68.4 combined road and trail kilometers. The Crater Lake effort recorded five of the 30 prioritized early detection invasive species across the park. The species, by descending abundance, included: Klamath weed (*Hypericum perforatum*), sheep sorrel (*Rumex acetosella*), dandelion (*Taraxacum officinale*), goat's beard (*Tragapogon dubius*). Table A.1 shows the percentage of segments infested. Some segments we surveyed had already been visited and the invasives were controlled by park staff, and our results show a false negative (East Rim Drive F and B, West Rim Drive B, Pinnacles B, Munson Valley to Rim B, and PCT Alternate A). We were restricted from sampling some selected segments due to fires in the west side of the park and maintenance along Highway 62 made several segments inaccessible this season. We attempted to survey Anderson Bluffs trail but were unable to find it. We supplemented these segments with other segments from our GRTS draw, to complete our minimum sample size of 25.

Table A.1. Summary of prioritized invasive species at Crater Lake National Park.

Species	Total # of infestations	# of segments infested	% of segments infested
<i>Hypericum perforatum</i>	8	3	12
<i>Rumex acetosella</i>	4	2	8
<i>Taraxacum officinale</i>	2	1	4
<i>Tragapogon dubius</i>	1	1	4

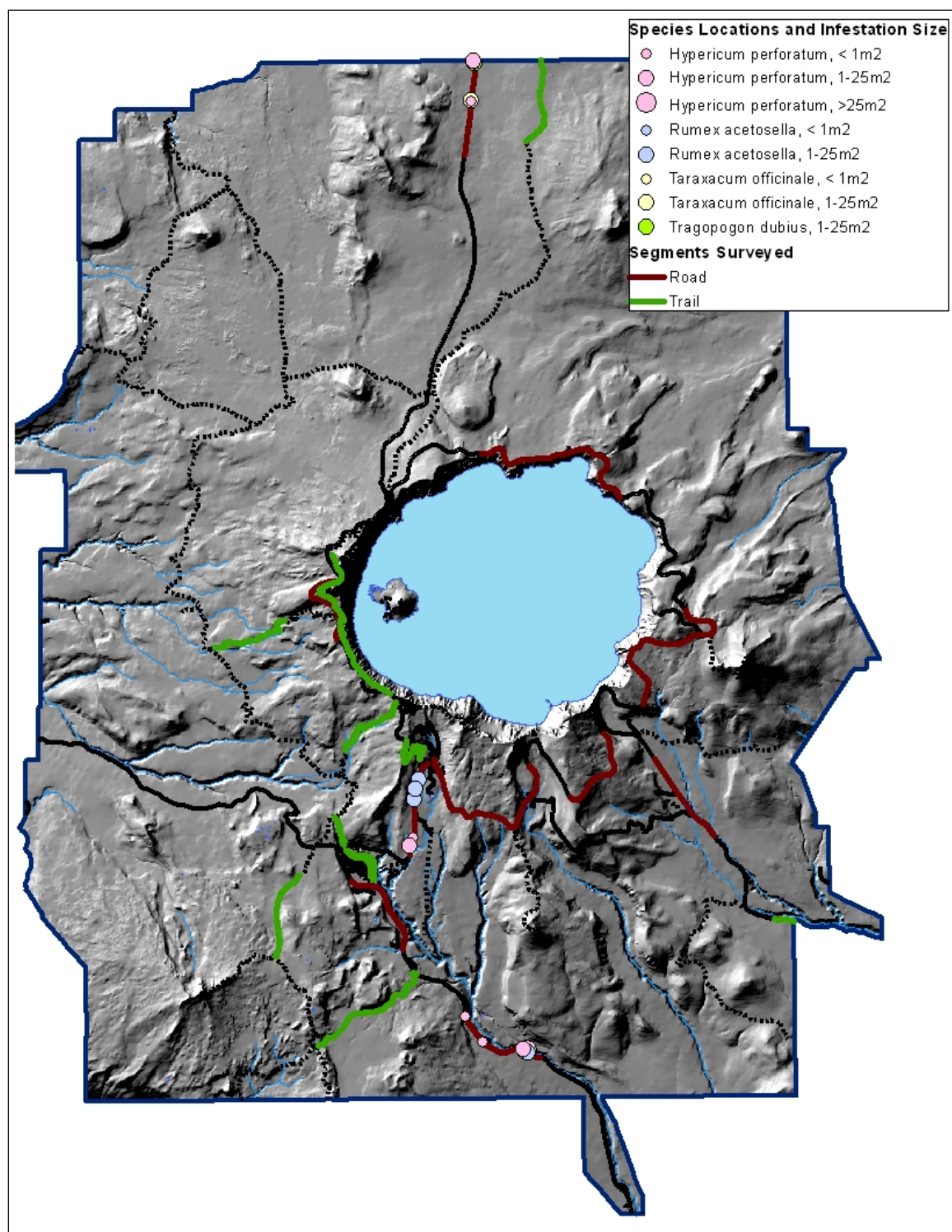


Figure A.1. Locations of invasive plant species recorded in FY 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

Appendix B: Lava Beds National Monument

Fiscal Year 2011 Accomplishments

The Klamath I&M program implemented, for the second time, its Invasive Species Early Detection Protocol from May to September 2011. During the season, a two person crew led by Alicia Fitzgerald visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 146 road and trail segments for a total of 350 km. The sample effort matched or exceeded expectations, which was particularly heartening for the second full season of implementation.

Park-specific Findings

Lava Beds was sampled between June 6 and June 13, then again from June 20 and 21, the height of the flowering season for most invasive species, and 26 segments, or 65.2 combined road and trail kilometers, were surveyed. The Lava Beds effort recorded five of the 18 prioritized early detection invasive species across the park. The species, by descending abundance, included: goat's beard (*Tragopogon dubius*), sweet clover (*Melilotus* sp.), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), flix weed (*Descurainia sophia*). Table B.1 shows the percentage of segments infested by each species.

Table B.1. Summary of prioritized invasive species at Lava Beds National Monument. Note an * indicates species only surveyed in wilderness areas.

Species	Total # of infestations	# of segments infested	% of segments infested
<i>Descurainia sophia</i> *	31	7	26.9
<i>Tragopogon dubius</i> *	29	10	38.5
<i>Melilotus</i> sp.	6	3	11.5
<i>Cirsium vulgare</i>	2	2	7.7
<i>Cirsium arvense</i>	1	1	3.9

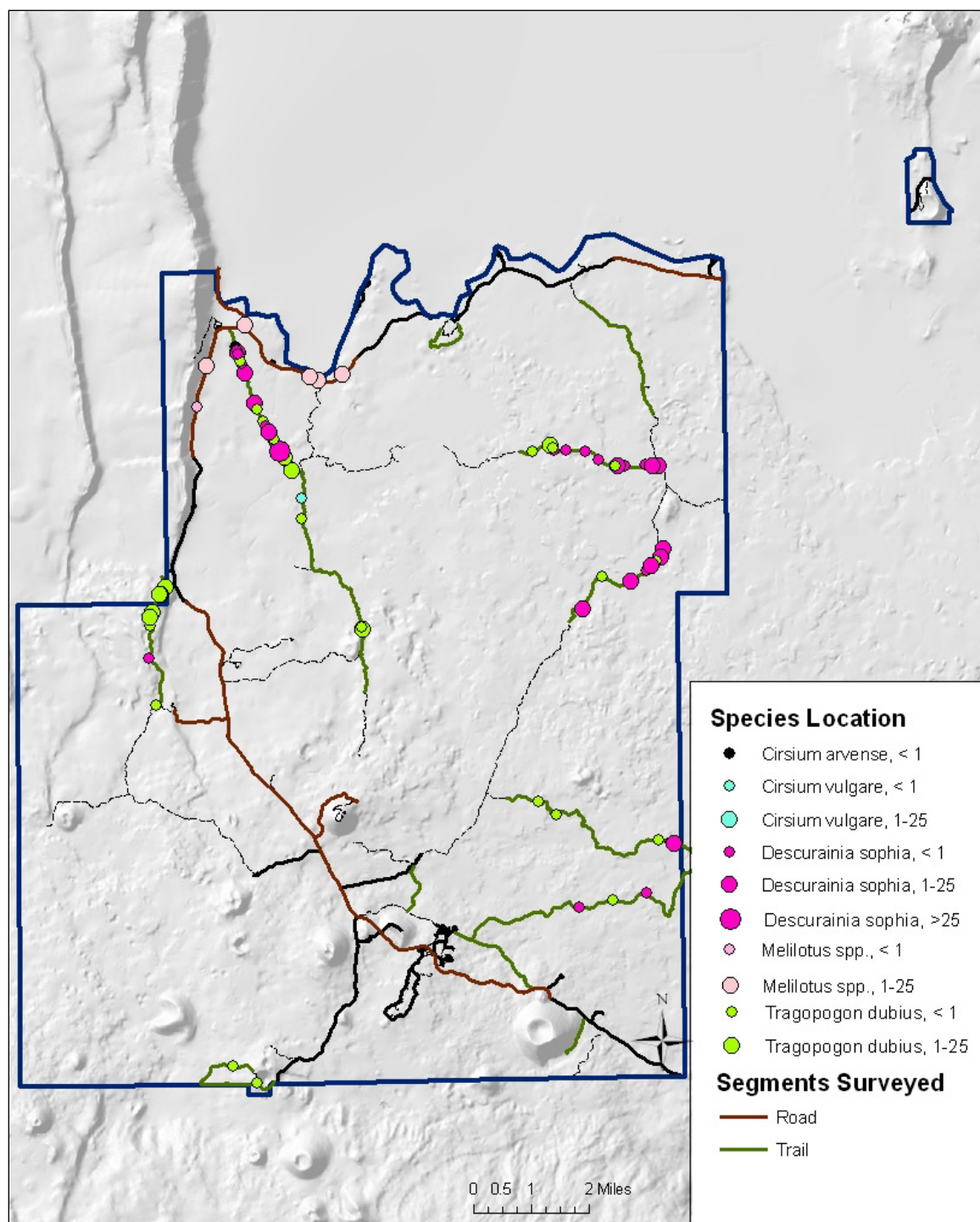


Figure B.1. Locations of invasive plant species recorded in the 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

Appendix C: Lassen Volcanic National Park

Fiscal Year 2009 Accomplishments

The Klamath I&M program implemented, for the second time, its Invasive Species Early Detection Protocol from May to September 2011. During the season, a two person crew led by Alicia Fitzgerald visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 146 road and trail segments for a total of 350 km. The sample effort matched or exceeded expectations, which was particularly heartening for the second full season of implementation.

Park-specific Findings

Lassen Volcanic was sampled between August 2 and August 7, and then again between August 15 and August 18, the height of the flowering season for most invasive species. Twenty five segments, or 65.7 combined road and trail kilometers, were sampled. The Lassen effort recorded 3 of the 30 prioritized early detection invasive species across the park. The species, by descending abundance, included: musk thistle (*Carduus nutans*), bull thistle (*Cirsium vulgare*), goat's beard (*Tragopogon dubius*). Table C.1 shows the percentage of segments infested by each species. We successfully coordinated with LAVO staff and we were able to complete our surveys before any control was implemented by park staff. The musk thistle observations (*Carduus nutans*), if confirmed would be a first occurrence at LAVO, these infestations should be confirmed.

Table C.1. Summary of prioritized invasive species at Lassen Volcanic National Park. Note an * indicates species only surveyed in wilderness areas.

Species	Total # of infestations	# of segments infested	% of segments infested
<i>Carduus nutans</i>	7	7	8
<i>Cirsium vulgare</i> *	7	4	16
<i>Tragopogon dubius</i> *	3	2	8

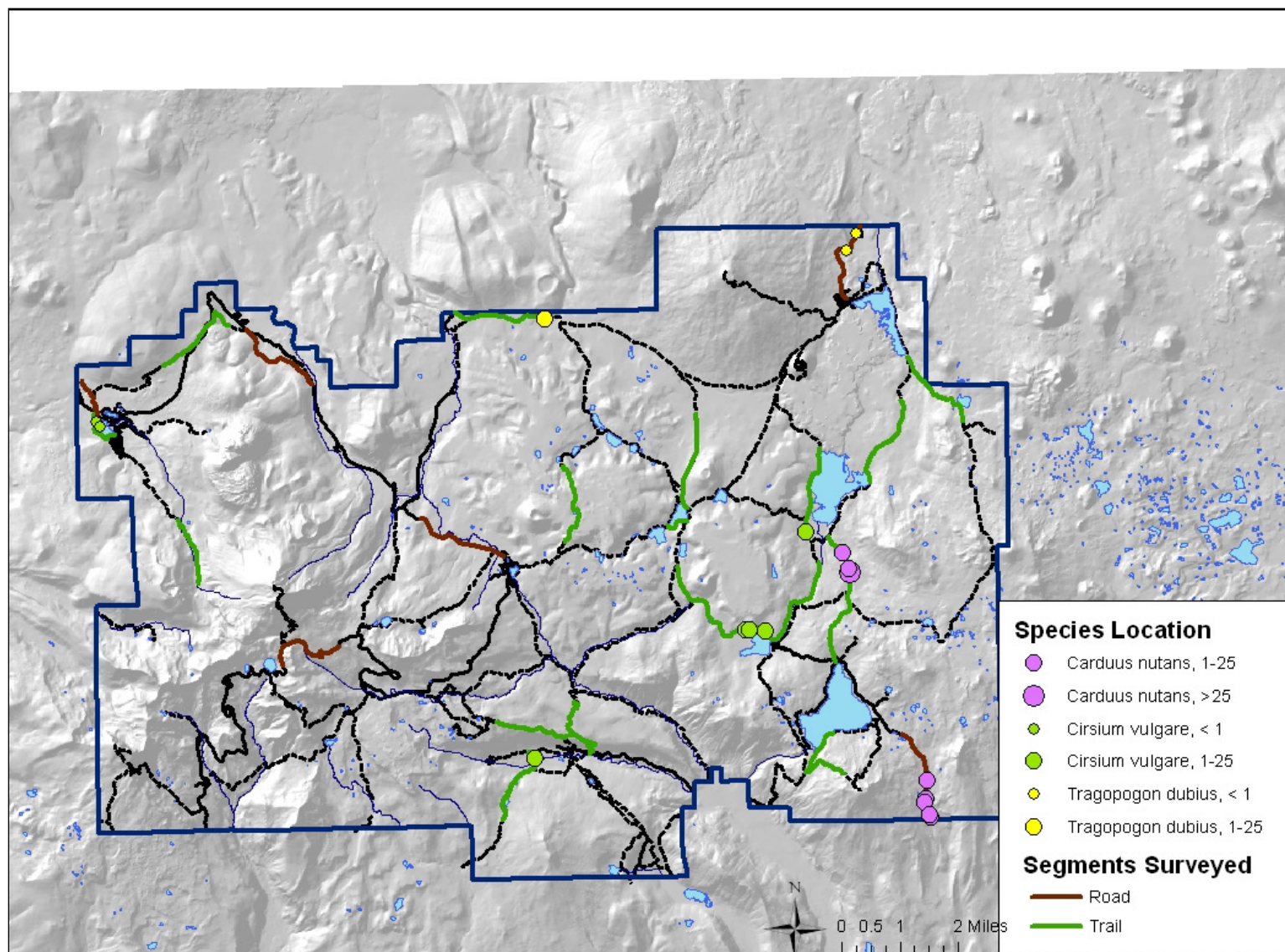


Figure C.1. Locations of invasive plant species recorded in the 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

Appendix D: Oregon Caves National Monument

Fiscal Year 2011 Accomplishments

The Klamath I&M program implemented, for the second time, its Invasive Species Early Detection Protocol from May to September 2011. During the season, a two person crew led by Alicia Fitzgerald visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 146 road and trail segments for a total of 350 km. The sample effort matched or exceeded expectations, which was particularly heartening for the second full season of implementation.

Park-specific Findings

Oregon Caves was sampled between July 18 to July 20, to capture the peak flowering season for most invasive species, and 10 segments or 11.5 combined road and trail kilometers were surveyed. The Oregon Caves effort recorded three of the six prioritized early detection invasive species across the park. The species, listed by descending abundance include: Klamath weed (*Hypericum perforatum*), orchard grass (*Dactylis glomerata*), and cheatgrass (*Bromus tectorum*). Table D.1 shows the percentage of segments infested by each species.

Table D.1. Summary of Prioritized invasive species at Oregon Caves National Park.

Species	Total # of infestations	# of segments infested	% of segments infested
<i>Hypericum perforatum</i>	5	3	30
<i>Dactylis glomerata</i>	4	3	30
<i>Bromus tectorum</i>	1	1	10

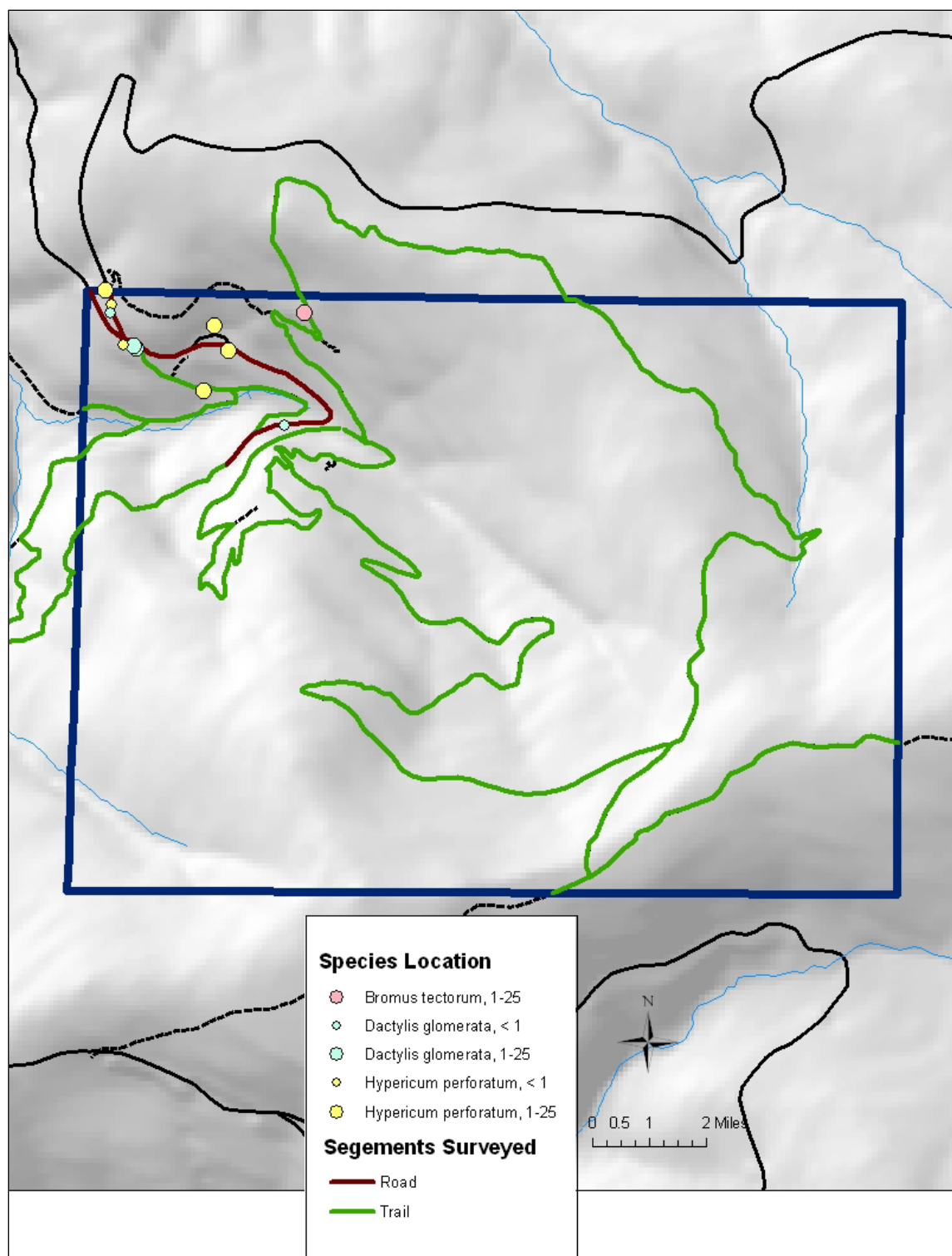


Figure D.1. Locations of invasive plant species recorded in the 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

Appendix E: Redwood National and State Park

Fiscal Year 2011 Accomplishments

The Klamath I&M program implemented, for the second time, its Invasive Species Early Detection Protocol from May to September 2011. During the season, a two person crew led by Alicia Fitzgerald visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 146 road and trail segments for a total of 350 km. The sample effort matched or exceeded expectations, which was particularly heartening for the second full season of implementation.

Park-specific Findings

Redwood was sampled between June 22 and June 27, July 5 and July 7, July 21 and July 25, then again from Sept 17 to Sept. 18, to capture the peak flowering season for most invasive species. Thirty five segments or 82.5 combined road and trail kilometers were surveyed. The Redwood effort recorded 9 of the 38 prioritized early detection invasive species across the park. The species listed in decreasing abundance included: Scotch broom* (*Cytisus scoparius*), Himalayan blackberry (*Rubus armeniacus*), bull thistle (*Cirsium vulgare*), English ivy (*Hedera helix*), fox glove (*Digitalis purpurea*), cut-leaved blackberry (*Rubus laciniatus*), cape ivy (*Delairea odorata*), French broom* (*Genista monspessulana*), Canada thistle (*Cirsium arvense*). Table E.1 shows the percentage of segments infested by each species. At Redwood we only completed 3 subsegments of L-2 A because the road has been decommissioned. The Boat Creek Trail, 205 A, and Davison Spur B segments could not be found, and will be removed from the sampling frame.

*NOTE: the ‘brooms’ were not in always in full phenological expression and may have been misidentified to species, but are for sure one of the two brooms listed as priority species.

Table E.1. Summary of Prioritized invasive species at Redwood National and State Park. Note * indicates species only monitored along trails.

Species	Total # of infestations	# of segments infested	% of segments infested
<i>Cytisus scoparius</i>	18	5	14.3
<i>Rubus armeniacus</i> *	9	3	8.6
<i>Cirsium vulgare</i> *	6	2	5.7
<i>Hedera helix</i> -	5	1	2.9
<i>Digitalis purpurea</i> *	3	1	2.9
<i>Rubus laciniatus</i>	2	1	2.9
<i>Delairea odorata</i>	2	2	5.7
<i>Genista monspessulana</i> *	1	1	2.9
<i>Cirsium arvense</i>	1	1	2.9

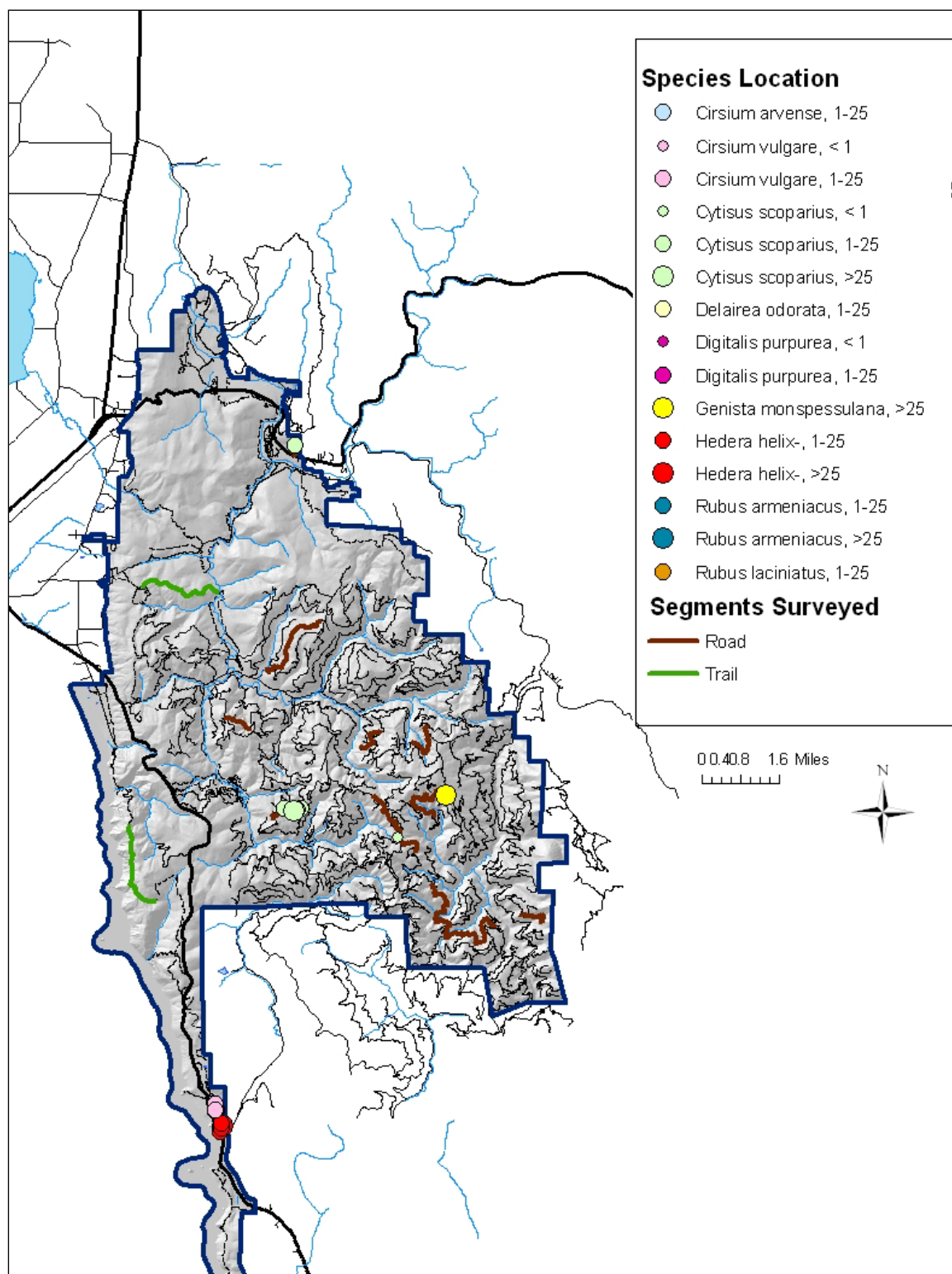


Figure E.1. Locations of invasive plant species recorded in FY 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

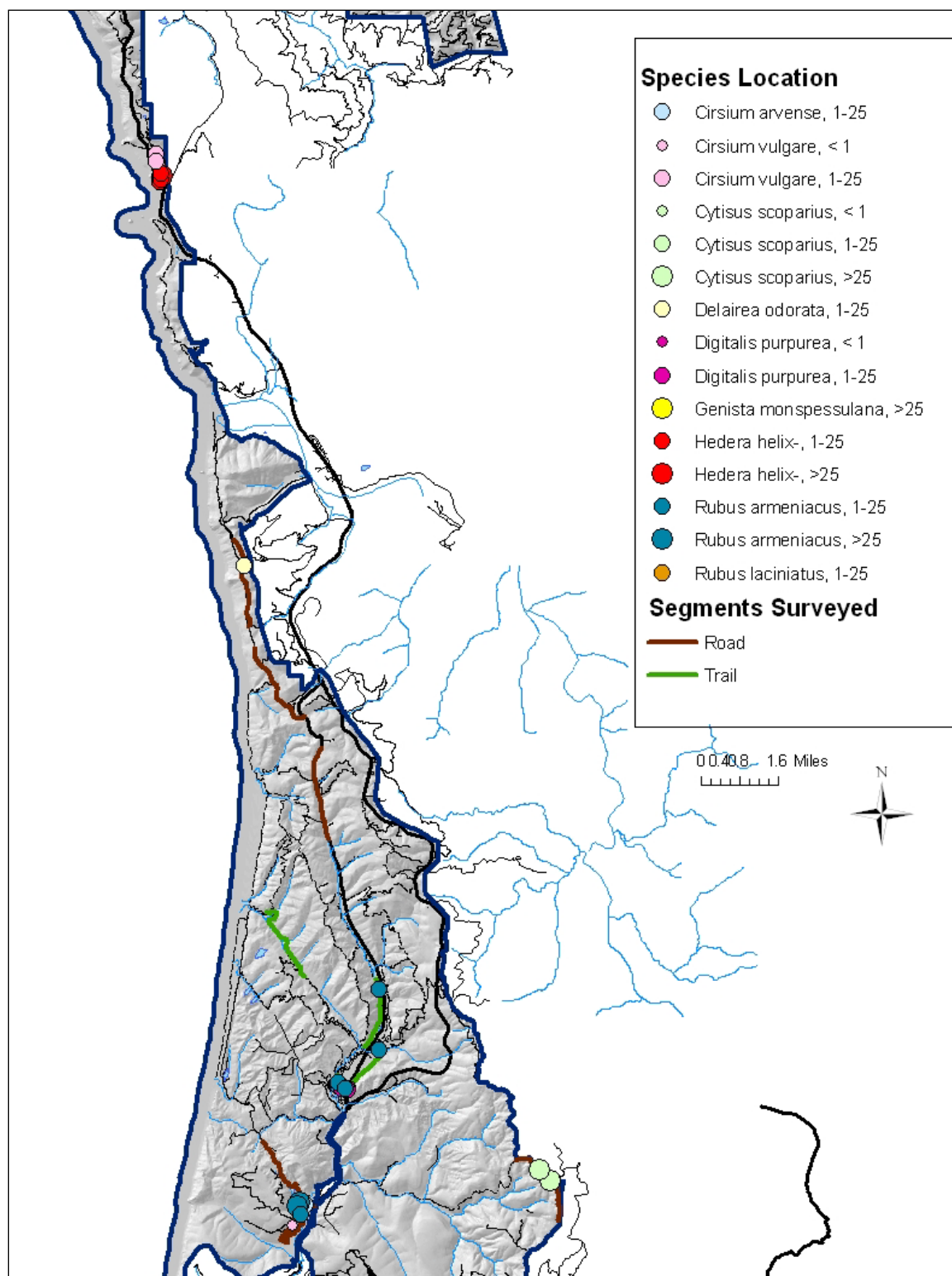


Figure E.1. Locations of invasive plant species recorded in FY 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year (continued).

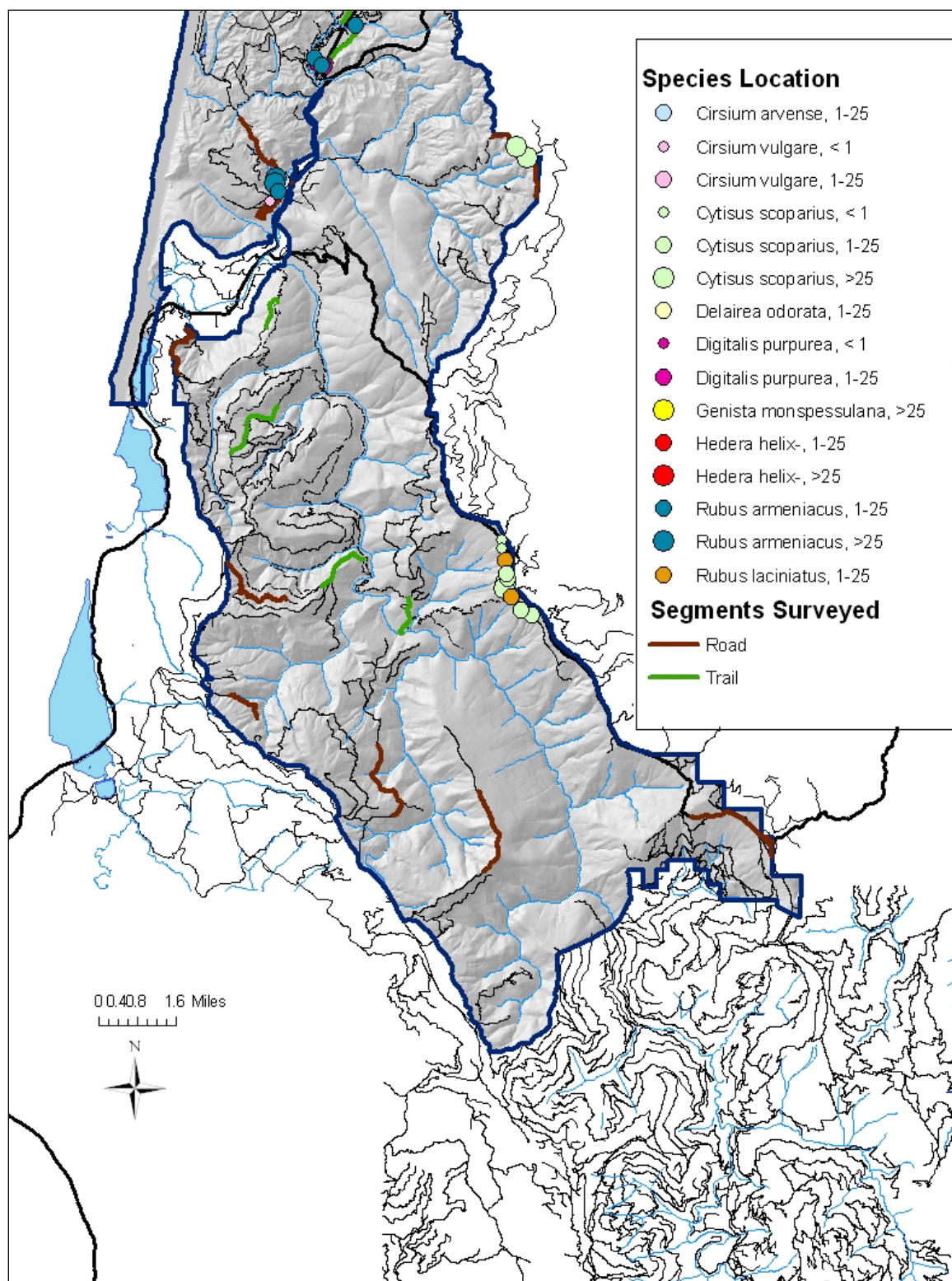


Figure E.1. Locations of invasive plant species recorded in the 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year (continued).

Appendix F: Whiskeytown National Recreation Area

Fiscal Year 2011 Accomplishments

The Klamath I&M program implemented, for the second time, its Invasive Species Early Detection Protocol from May to September 2011. During the season, a two person crew led by Alicia Fitzgerald visited all six parks in the Klamath Network, beginning the season in Whiskeytown NRA and concluding in Redwood NSP. The crew visited 146 road and trail segments for a total of 350 km. The sample effort matched or exceeded expectations, which was particularly heartening for the second full season of implementation.

Park-specific Findings

Whiskeytown was sampled between May 10 and May 13, May 2 and May 29 then again from July 9 to July 10. The lower elevations were completed first to capture the peak flowering season for most invasive species and 25 segments, or 56.2 combined road and trail kilometers, were surveyed. The Whiskeytown effort recorded 12 of the 34 prioritized early detection invasive species across the park. The species, listed in decreasing abundance included: Scotch broom* (*Cytisus scoparius*), star thistle (*Centaurea solstitialis*), tree of heaven (*Ailanthus altissima*), common mullein (*Verbascum thapsus*), spotted knapweed (*Centaurea maculosa*), vernal grass (*Anthoxanthum odoratum*), Spanish broom* (*Spartium junceum*), bull thistle (*Cirsium vulgare*), Himalaya blackberry (*Rubus armeniacus*), French broom* (*Genista monspessullana*), tall fescue (*Festuca arundinacea*), and Asian mustard* (*Brassica tournefortii*). Table F.1 shows the percentage of segments infested by each species. Mill Creek C could not be done due to high water and Shasta Divide Trail B, could not be found. *NOTE: the Asian mustard infestation was not collected, but photographed. The identification of the species is not conclusive from the photo, and the infestation should be revisited and verified. Also some of the 'brooms' were not in full phonological expression and may have been misidentified to species, but are for sure one of the three listed as priority species. Spotted knapweed (*Centaurea maculosa*) observations along the Shasta bally Road are considered tentative at this time.

Table F.1. Summary of prioritized invasive species at Whiskeytown National Recreation Area. Note * indicates species only surveyed above 2500ft.

Species	Total # of infestations	# of segment infestations	% of segments infested
<i>Cytisus scoparius</i>	12	6	24
<i>Centaurea solstitialis</i> *	9	5	20
<i>Ailanthus altissima</i>	7	4	16
<i>Verbascum thapsus</i> *	6	4	16
<i>Centaurea maculosa</i>	5	2	8
<i>Anthoxanthum odoratum</i>	5	4	16
<i>Spartium junceum</i>	3	1	4
<i>Cirsium vulgare</i>	2	2	8
<i>Genista monspessullana</i>	1	1	4
<i>Festuca arundinacea</i>	1	1	4
<i>Brassica tournefortii</i>	1	1	4

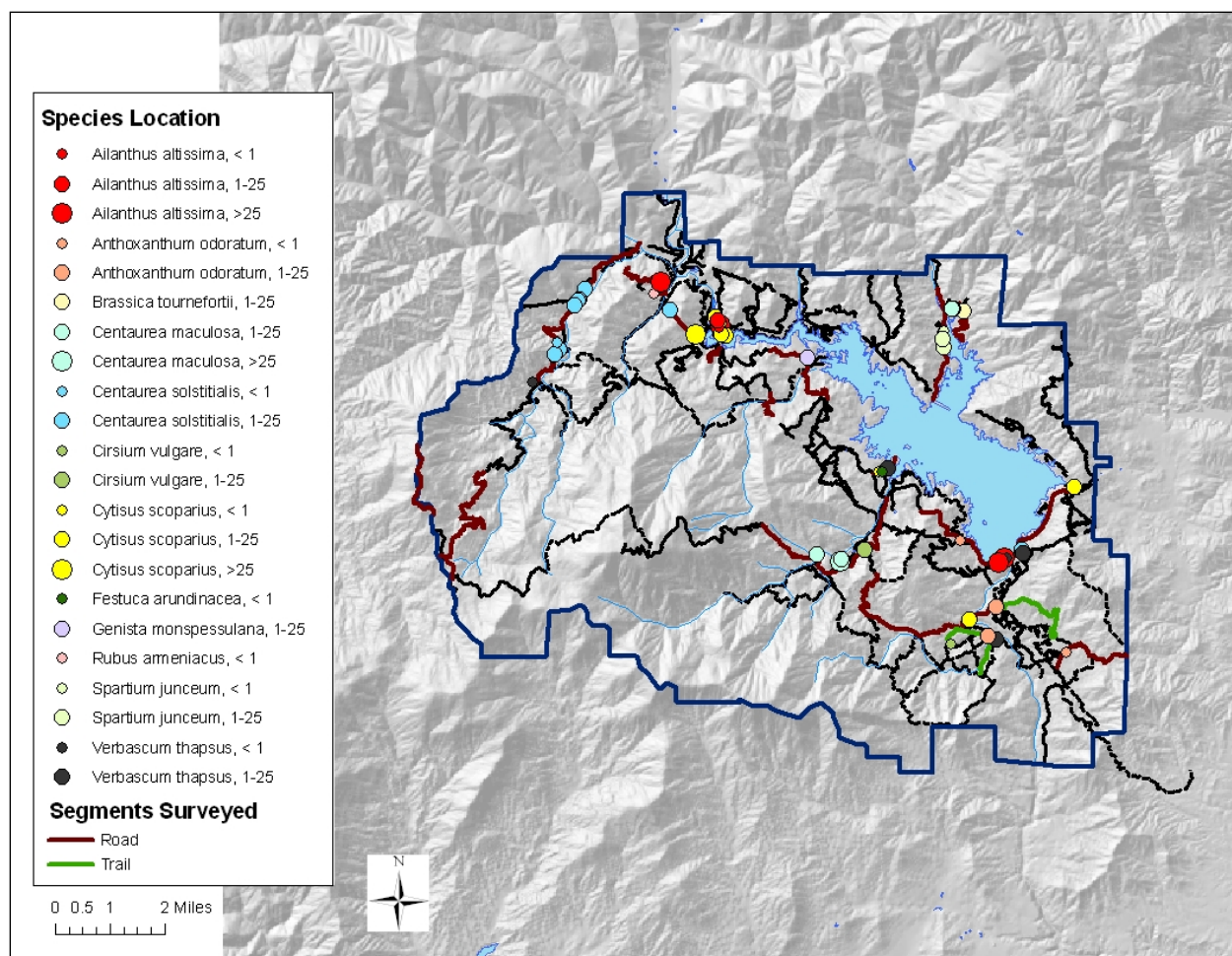


Figure F.1. Locations of invasive plant species recorded in the 2011 Invasive Species Early Detection monitoring. Note that not all road or trail segments are sampled each year.

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National Park Service
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