



Invasive Exotic Plant Monitoring in Zion National Park

2012 Field Season

Natural Resource Technical Report NPS/NCPN/NRTR—2013/749



ON THE COVER

Bulbous bluegrass (*Poa bulbosa*). Photo ©Patrick J. Alexander.

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Abstract

Invasive exotic plant (IEP) species are a significant threat to natural ecosystem integrity and biodiversity, and controlling them is a high priority for the National Park Service. The Northern Colorado Plateau Network (NCPN) selected the early detection of IEPs as one of 10 monitoring protocols to be implemented as part of its long-term monitoring program. During surveys conducted on June 8–13, 2012, NCPN staff detected 11 IEP species (five of which were priority species) on monitoring routes and transects along 113.7 kilometers of roads and trails at Zion National Park. Bulbous bluegrass (*Poa bulbosa*), Siberian elm (*Ulmus pumila*), and Johnson grass (*Sorghum halepense*) were the most commonly detected priority invasive plants. Many monitoring routes had few (<1 infestation/ha) infestations and several had none. However, the road by the Watchman Campground and visitor center (9.76 infestations/ha), Weeping Rock Trail (4.49/ha) and the Zion Scenic Drive (2.21/ha) all had high numbers of infestations. While infestations were widespread, actual IEP percent cover was low ($\leq 0.10\%$) along roads and trails.

Acknowledgements

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1 Introduction

Invasive exotic species fragment native ecosystems, displace native plants and animals, and alter ecosystem function. Invasive species are second only to habitat loss as threats to global biodiversity (Scott and Wilcove 1998) and represent one of the most serious threats to natural ecosystem integrity (NRC 2002). Biological invasions are occurring at accelerated rates in nearly every major ecosystem (Mooney and Hobbs 2000). Exotic plants negatively affect park resources and visitor enjoyment by altering landscapes and fire regimes, reducing native plant communities and animal habitat, and increasing trail-maintenance needs. Recognizing these challenges, Northern Colorado Plateau Network (NCPN) parks identified invasive exotic plants (IEPs) as a high-priority vital sign for long-term monitoring (O'Dell et al. 2005).

IEPs are a subset of exotic plants, “whose introduction does or is likely to cause economic or environmental harm or harm to human health” (Executive Order 13112). With the aim of facilitating strategic control approaches, this monitoring program detects early invasions, identifies existing invasions, and, to the extent possible, tracks changes in the abundance and distribution of priority IEPs in parks along key invasive pathways.

Invasive exotic plants can spread into national parks via a number of different pathway types. Predictable IEP pathways include roads, trails, and riparian corridors. Long-distance dispersal through cargo containers and air freight are examples of sudden

pathways. Anthropogenic pathways include horticultural escapes and seeds transported on shoes and in restoration seed mixes. For the National Park Service (NPS), the consequences of these plant invasions present a significant challenge to the agency’s ability to maintain natural resources “unimpaired for the enjoyment of future generations.”

Because regular, comprehensive monitoring of the distribution and abundance of all exotic plant species within NCPN units is beyond the fiscal capabilities of the network and parks, the NCPN is focusing on the most likely areas where a broad range of invasive exotic plants may occur: riparian corridors, roads, trails, areas of high visitor impact (e.g., campgrounds), and park boundaries. This approach is cost-effective for finding many new invasions in areas where they are most likely to occur, but it may miss exotic plants dispersed to the interior areas of large parks by wind and/or animals.

Specific objectives of NCPN invasive exotic plant monitoring are:

1. To detect incipient populations and new introductions of invasive plant species before they become established in areas of management significance and invasion pathways; and
2. To determine status and trends of selected invasive plant populations of management significance.

This report summarizes the 2012 field season at Zion National Park (NP).

2 Methods

We followed the invasive exotic plant monitoring protocol developed by the NCPN (Perkins et al. in review), adapted from Andersen and Dewey (2007). The protocol emphasizes the quick collection of IEP location and abundance data in order to maximize the amount of area searched, thus increasing our chances of finding a higher percentage of both new invasions and established IEPs. By focusing on roads, trails, and waterways, which are major vectors for invasive plants, we will capture the greatest amount of information (i.e., benefit) with the least amount of time and effort (i.e., cost).

2.1 Developing a park target invasive exotic plant list

Prior to beginning monitoring in 2012, NCPN and Zion NP staff reviewed the park's list of priority IEPs. The list was developed by reviewing past park literature and state and county weed lists, and consulting with park staff and county weed managers. Our high-priority target IEP list includes existing IEPs and potential IEPs of high management concern. Because these methods are designed to be rapid, field crews are trained to develop a focused search image on the target plants, instead of looking for every possible invasive plant species. The likelihood of eradicating these target species, or containing them within a park, is generally high.

2.2 Monitoring routes

2.2.1 Minimum detection target size

The minimum detection target size (MDTS) represents the patch size that is large enough to be detected with a high level of confidence (typically at least 90% of the total number of patches of that size and larger in the monitoring area) under actual field conditions, but small enough so that any missed patches smaller than the MDTS could still feasibly be eradicated if not found until the next scheduled monitoring visit. We established an MDTS of 40 m² (0.01 acres or approximately 20 × 20 ft) for all IEPs. Use of the MDTS was necessary because field technicians are not expected to find every single plant of every targeted weed species during route surveys.

Searching for single mature plants of some species, such as Siberian elm (*Ulmus pumila*), is possible due to their large size. Single plants of other species, such as Medusahead (*Taeniatherum caput-medusae*), are nearly impossible to detect in most field conditions.

2.2.2 Effective detection distance

The effective detection distance (EDD) is the maximum distance from which a searcher could consistently detect (i.e., see and recognize) the MDTS of the least-visible targeted species with at least 90% detection efficiency (Figure 2-1). Using fake plants of a targeted size, crew members are trained by walking away and determining the maximum distance from which they can consistently see and

Table 2-1. Priority invasive plant list, Zion NP, 2012.

Scientific name	Common name
<i>Alhagi maurorum</i>	camelthorn
<i>Brassica tournefortii</i>	Sahara mustard
<i>Cardaria draba</i>	hoary cress
<i>Carduus nutans</i>	musk thistle
<i>Centaurea diffusa</i>	diffuse knapweed
<i>Centaurea melitensis</i>	Maltese starthistle
<i>Centaurea repens</i>	Russian knapweed
<i>Centaurea solstitialis</i>	yellow starthistle
<i>Centaurea squarrosa</i>	squarrose knapweed
<i>Cirsium arvense</i>	Canada thistle
<i>Conium maculatum</i>	poison hemlock
<i>Cynodon dactylon</i>	Bermuda grass
<i>Eragrostis cilianensis</i>	stinkgrass
<i>Euphorbia esula</i>	leafy spurge
<i>Hyoscyamus niger</i>	black henbane
<i>Hypericum perforatum</i>	St. Johnswort
<i>Isatis tinctoria</i>	Dyer's woad
<i>Kochia scoparia</i>	kochia
<i>Lepidium latifolium</i>	broad-leaf pepperwort
<i>Leucanthemum vulgare</i>	ox-eye daisy
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Linaria vulgaris</i>	butter-and-eggs
<i>Lythrum salicaria</i>	purple loosestrife
<i>Onopordum acanthium</i>	Scotch thistle
<i>Poa bulbosa</i>	bulbous bluegrass
<i>Potentilla recta</i>	sulfur cinquefoil
<i>Sorghum halepense</i>	Johnson grass
<i>Taeniatherum caput-medusae</i>	Medusahead
<i>Ulmus pumila</i>	Siberian elm

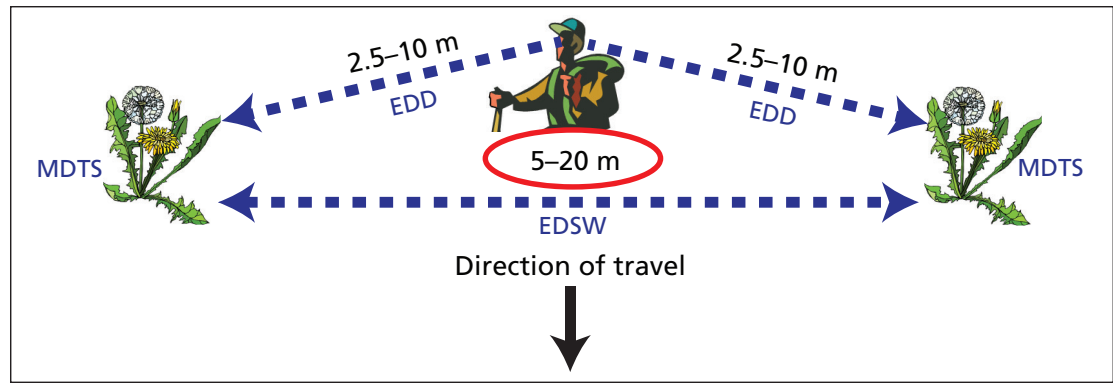


Figure 2-1. The maximum effective detection distance (EDD) at Zion National Park ranged from 2.5 to 10 meters, making the effective detection swath width (EDSW) 5–20 meters.

recognize the patch with complete confidence. The size of the EDD is then estimated in the field by crew members. The distance is measured either by pacing or using a laser rangefinder. The EDD for Zion NP in 2012 ranged from 2.5 to 10 m.

2.2.3 Effective detection swath width

Effective detection swath width (EDSW) is defined as the maximum width of a linear search swath (band transect) in which a walking observer is confident of visually detecting 90% of all target species of the MDTs (Figure 2-1). The effective detection swath width (EDSW) is equal to two times the EDD, because the surveyor is able to effectively detect weeds for one EDD on either side of his/her search route. The EDSW ranged from 5 to 20 m at Zion NP in 2012.

2.2.4 Patch separation resolution

We define patch separation resolution as the minimum distance between plants that must be considered members of separate patches or infestations. Individuals or clusters of a target species separated by the PSR distance or more are recorded as separate patches. We consider plants separated by less than the PSR to be a single patch or infestation. The PSR is set at 50 m, based on the assumption that most plants or groups of plants separated by less than 50 m are typically considered to be one infestation during planning and implementation of weed-control operations. If an infestation is continuous for more than 50 m, cover estimates are made every 50 m to aid in developing an effective management strategy for the entire infestation.

2.2.5 Between feature position

Between feature positions allow electronic tracking of a user's route. A GPS (global positioning system) unit is set to automatically generate these positions at a distance equal to the EDSW. Each time a surveyor walks the equivalent of one EDSW, the GPS unit creates a point.

2.2.6 Data collection methods

We established monitoring routes with advice from Zion NP staff (Figure 2-2). While walking, we searched for IEPs by visually scanning (side-to-side) all of the land within the borders of the swath. However, if the terrain was uneven or steep, and the observer had to glance frequently at the ground to ensure safe foot placement, then searchers stopped approximately every 20 m (the length of one EDSW) and visually scanned the area in all directions. As monitoring routes were traversed, locations of all target species were documented using GPS units with at least five-meter accuracy. Only priority species were consistently recorded during monitoring routes. Survey crew members were permitted to record additional species if they were noteworthy.

When a priority IEP was discovered, we recorded the following information: (1) the monitoring route, (2) the sequential number of the invasion per monitoring route, (3) infestation size class (see below), (4) whether the plant was pulled, and (5) canopy cover class (see below). If several species were present with similar distributions at a single point, we recorded a point for each individual species and assigned it its own sequential

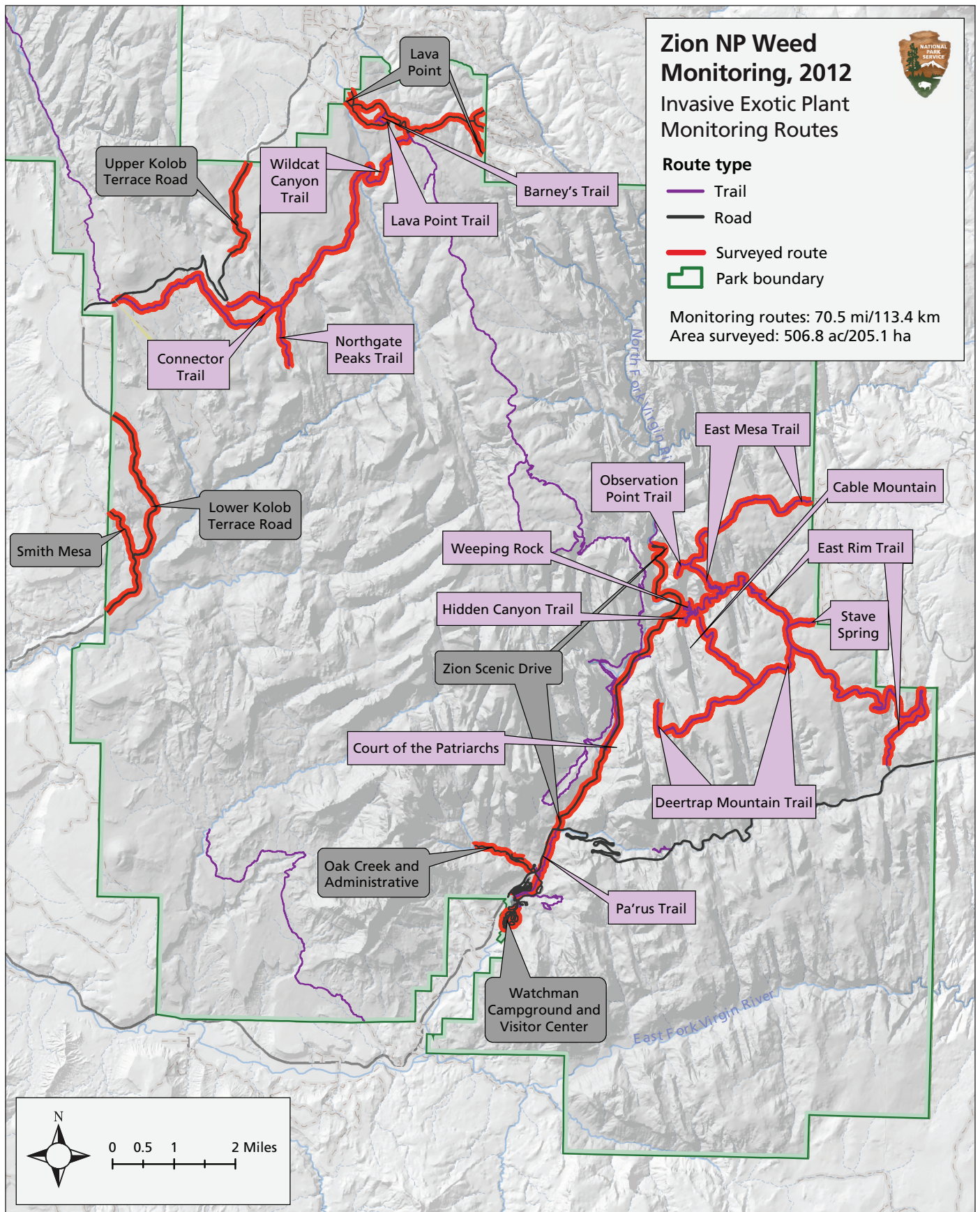


Figure 2-2. Overview of invasive plant monitoring routes surveyed at Zion National Park, June 8–13, 2012.

identification number. Invasions more than 50 m (55 yards) apart were considered separate invasions and recorded with separate points.

Infestation size class was estimated as follows:

1. 1–a few plants (used for isolated single plants or very small patches ($\leq 2 \times 2$ m),
2. few plants–40 m² (48 yd²),
3. 40–400 m² (48–478 yd²),
4. 400–1,000 m² (0.1–0.25 acre), and
5. 1,000–2,000 m² (0.25–0.5 acre).

We recorded canopy cover class by estimating the amount, or “percentage,” of ground covered by the vertical projection of plant matter as visualized from a bird’s-eye view of the vegetation (Elzinga et al. 1998). This estimate included both the living and dead standing material of the vegetation of a single plant species. Canopy cover of a patch was recorded using the following classes:

1. Trace (<1%)
2. Low (1–5%)
3. Moderate (6–25%)
4. High (26–50%)
5. Majority (51–100%).

We recorded the following ancillary information with every infestation: descriptive notes (e.g., hillside, distance to road, wetland, stream), the growth stage of exotic trees (e.g., sapling, pole, mature), evidence of prior treatment, and evidence of disturbances (e.g., recent fire, flood, small mammal disturbance).

2.3 Monitoring transects

We established transects with three vegetation quadrats every 500 m along monitoring routes (see Figures 2-3, 2-4). Our methods for sampling the monitoring quadrats were based on Stohlgren and others (2005). If no invasives were detected for four consecutive transects (12 quadrats), then transects were established every 1,000 m. If invasive plants were found in categories greater than 1 for canopy cover class or infestation size class, then we reverted to establishing transects every 500 m.

2.3.1 Quadrat establishment

We centered vegetation quadrats at 0.5, 5, and 10 m away from the edge of a road on the same side as the route being walked and on alternating sides for riparian areas, small roads, or trails. A 1-m² sampling frame, used to sample vegetation cover and soil surface features, was placed on the right side of the transect line as the technician walked the monitoring route. In some cases, we leveled the sampling frame by propping up quadrat corners.

2.3.2 Data collection methods

In the monitoring quadrats, all priority IEP species observed were recorded, as well as cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola tragus*). For each quadrat, we recorded percent cover of each IEP using the following classes: <1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, 50, 60, 70, 80, 90, or 100%. We also recorded percent cover, to the nearest 10%, of dominant soil surface features (i.e., dead wood, dung, fungus, lichen, litter/duff, live root/bole, mineral soil/sediment, moss, biological soil crust, road, rock, standing water/flooded, stream, or trash/junk).

2.4 Analyses

We calculated the mean number of infestations per 100 m for monitoring routes. Percent cover estimates were generated from the monitoring quadrat data. We calculated the mean and standard error of percent cover by species for monitoring quadrats. Due to differences in observers’ knowledge, only priority species should be used when comparing results from year to year.

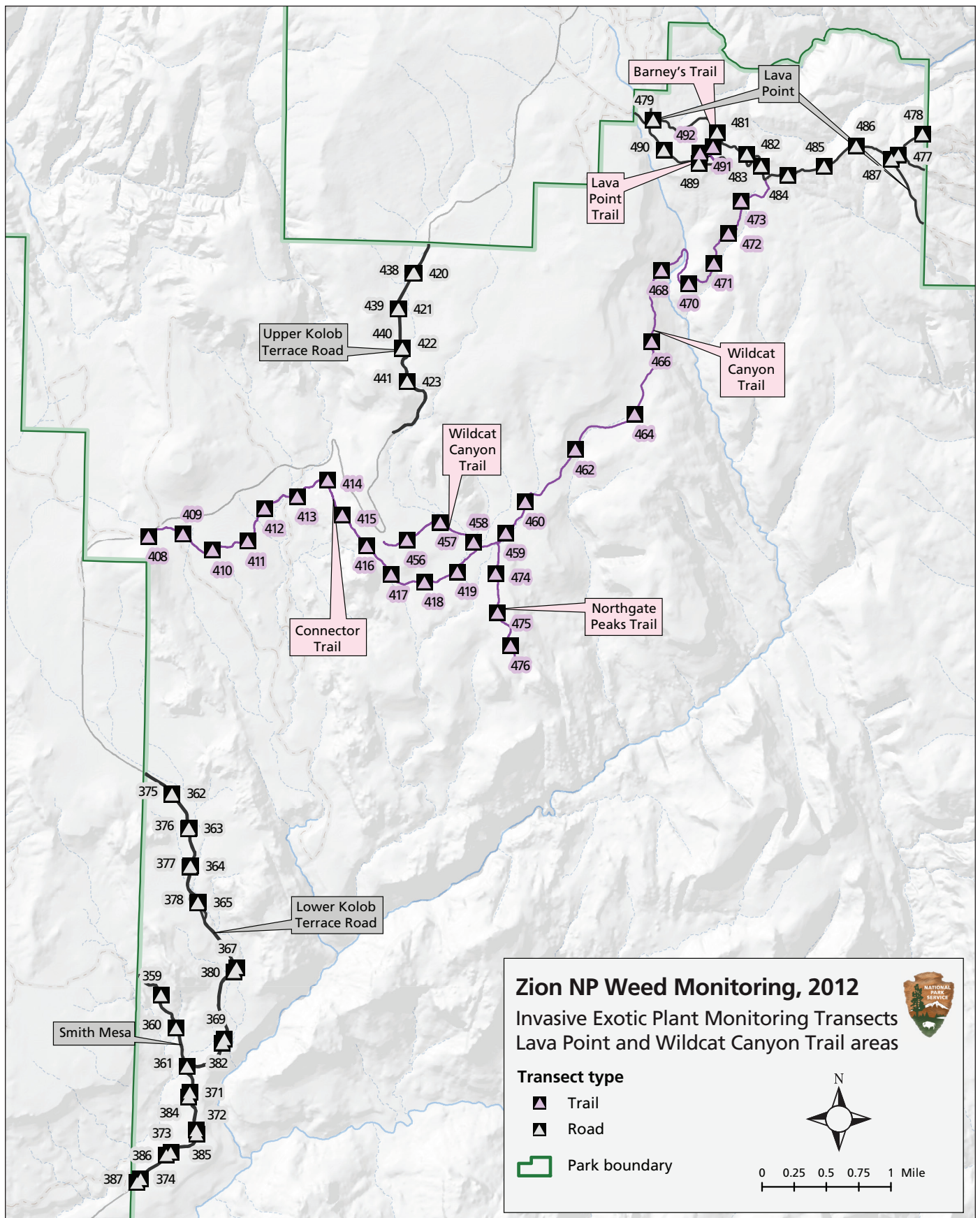


Figure 2-3. Monitoring routes and transects in the Lava Point and Wildcat Canyon Trail areas, Zion National Park, June 8–13, 2012.

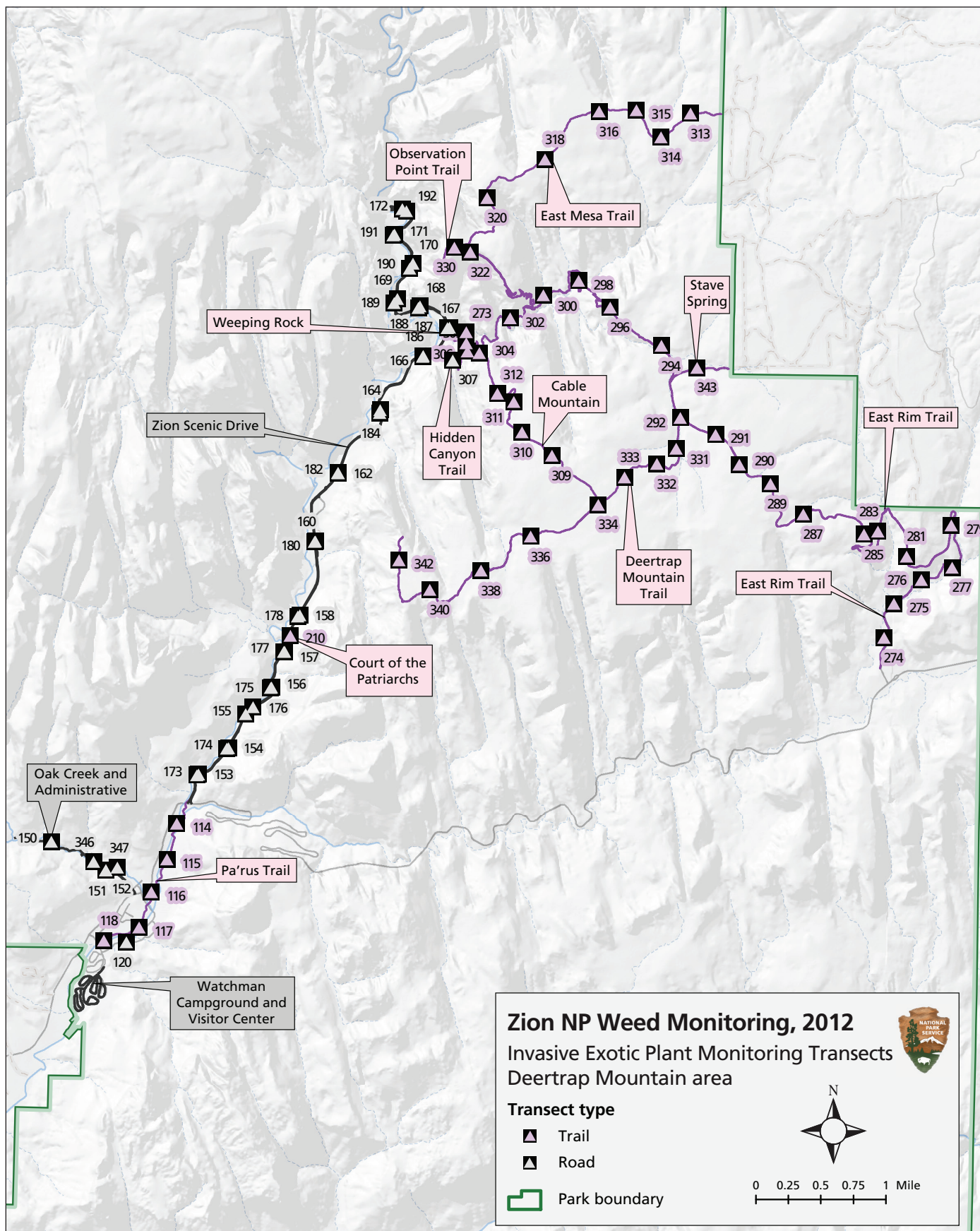


Figure 2-4. Monitoring routes and transects in the Deertrap Mountain area, Zion National Park, June 8–13, 2012.

3 Results

3.1 Target invasive exotic plant list

There are 29 IEP species identified as priority species on the Zion NP list (see Table 2-1). Observers are trained to recognize priority species, but given the freedom to map additional species; therefore, presence and absence data for priority species are reliable for the areas searched, but absence data for non-priority species are suspect.

We recorded a total of 11 IEP species on monitoring routes and transects in 2012 (Table 3-1). All 11 of those species were recorded on monitoring routes and two on monitoring transects. Of the IEP species detected, five were priority species (Table 3-1). We covered 205.54 hectares (507.9 acres) along 113.7 km (70.27 miles) of monitoring routes in 2012.

3.2 Monitoring routes

A total of 160 priority infestations (195 total infestations) of five different priority species were detected along the monitoring routes (Table 3-2; Figures 3-1, 3-2, 3-3, 3-4, 3-5, 3-6, 3-7; Electronic Appendix A; figures start on page 12) in 2012. The most common priority invasive species were bulbous bluegrass (*Poa bulbosa*), Siberian elm (*Ulmus pumila*), and Johnson grass (*Sorghum halepense*). These three species represented 96% of the priority infestations found.

Woolly mullein (*Verbascum thapsus*) was not a priority species, but was familiar to crews due to its widespread prevalence in NCPN parks, so many crew members recorded it when observed. The Watchman Campground and visitor center area had, by far, the highest number of priority infestations (9.76/ha) of any route (see Table 3-2). Weeping Rock Trail (4.49/ha) was the only trail with more than one priority infestation per hectare. The Zion Scenic Drive had the third-highest number of priority infestations (2.21/ha). All other routes had less than one priority infestation per hectare.

Of the 160 priority infestations, 37% were larger than 40 m² (Table 3-3). Siberian elm was the only exotic tree species detected. Of the 37 tree infestations, 17 were seedlings, 4 were in the sapling stage, and 16 were mature trees (see Electronic Appendix A).

3.3 Monitoring transects

A total of 161 transects were sampled in 2012 (Table 3-4; see Figures 2-3, 2-4, Appendix B). Two IEP species were detected, only one of which was a priority species (bulbous bluegrass). IEPs were only found on 12 transects (7% of transects), with an average of 0.07 IEP species detected per plot. Percent cover of these invasives was very low, with the highest cover being 0.10% for bulbous bluegrass occurring along the Zion Scenic Drive.

Table 3-1. Invasive exotic plants detected at Zion, June 8–13, 2012.

Scientific name	Common name	Method detected		Priority?
		Routes	Transects	
<i>Cynodon dactylon</i>	Bermuda grass	X		Yes
<i>Onopordum acanthium</i>	Scotch thistle	X		Yes
<i>Poa bulbosa</i>	bulbous bluegrass	X	X	Yes
<i>Sorghum halepense</i>	Johnson grass	X		Yes
<i>Ulmus pumila</i>	Siberian elm	X		Yes
<i>Agropyron cristatum</i>	crested wheatgrass	X		No
<i>Medicago sativa</i>	alfalfa	X		No
<i>Melilotus officinalis</i>	yellow sweetclover	X	X	No
<i>Sonchus asper</i>	spiny sowthistle	X		No
<i>Tragopogon dubius</i>	yellow salsify	X		No
<i>Verbascum thapsus</i>	woolly mullein	X		No

Table 3-2. Number of IEP infestations and infestations/ha by route and route type, Zion NP, June 8–13, 2012.

Route	Length (m)	Area (ha)	Infestations		Infestations/ha	
			Total	Priority only	Total	Priority only
Roads						
Watchman CG and VC	3,422.2	6.56	64	64	9.76	9.76
Zion Scenic Drive	20,513.0	20.41	51	45	2.50	2.21
Upper Kolob Terrace	5,807.2	7.58	19	7	2.51	0.92
Lower Kolob Terrace	13,082.7	13.49	12	8	0.89	0.59
Lava Point	7,889.9	12.57	5	0	0.40	0.00
Oak Creek + Administrative	3,669.3	4.83	3	1	0.62	0.21
Smith Mesa	3,120.6	3.02	0	0	0.00	0.00
<i>Roads total</i>	<i>57,505.0</i>	<i>68.44</i>	<i>154</i>	<i>125</i>	<i>2.38</i>	<i>1.96</i>
Trails						
Wildcat Canyon	9,380.4	17.92	19	16	1.06	0.89
East Rim	16,921.9	40.54	13	13	0.32	0.32
Weeping Rock	297.8	0.89	4	4	4.49	4.49
Observation Point	596.2	0.59	2	0	3.39	0.00
Connector	6,024.7	23.92	1	0	0.04	0.00
Hidden Canyon	902.8	2.05	1	1	0.49	0.49
Northgate Peaks	1,745.3	6.96	1	1	0.14	0.14
Barney's	418.4	0.62	0	0	0.00	0.00
Cable Mountain	2,889.5	2.88	0	0	0.00	0.00
Court of the Patriarchs	90.7	0.15	0	0	0.00	0.00
Deertrap Mountain	6,244.0	17.58	0	0	0.00	0.00
East Mesa	7,041.5	11.77	0	0	0.00	0.00
Lava Point	309.1	0.48	0	0	0.00	0.00
Pa'rus	2,513.0	7.59	0	0	0.00	0.00
Stave Spring	815.6	3.17	0	0	0.00	0.00
<i>Trails total</i>	<i>56,190.7</i>	<i>137.10</i>	<i>41</i>	<i>35</i>	<i>0.66</i>	<i>0.42</i>
2012 total	113,695.7	205.54	195	160	1.16	0.87

Table 3-3. Number of infestations by species and infestation size class detected along monitoring routes, Zion NP, June 8–13, 2012.

Scientific name	Common name	Total infestations	Infestation size class*					
			1	2	3	4	5	Unrecorded
Priority species								
<i>Poa bulbosa</i>	bulbous bluegrass	88	13	33	32	10	0	0
<i>Ulmus pumila</i>	Siberian elm	37	6	16	12	3	0	0
<i>Sorghum halepense</i>	Johnson grass	28	12	15	1	0	0	0
<i>Onopordum acanthium</i>	Scotch thistle	5	2	2	0	1	0	0
<i>Cynodon dactylon</i>	Bermuda grass	2	1	1	0	0	0	0
<i>Priority species</i>		160	34	67	45	14	0	0
Non-priority species**								
<i>Verbascum thapsus</i>	woolly mullein	26	7	4	1	0	0	14
<i>Agropyron cristatum</i>	crested wheatgrass	2	1	1	0	0	0	0
<i>Mellilotus officinalis</i>	yellow sweetclover	2	0	0	0	0	2	0
<i>Sonchus asper</i>	spiny sowthistle	2	0	1	0	0	0	1
<i>Tragopogon dubius</i>	yellow salsify	2	1	1	0	0	0	0
<i>Medicago sativa</i>	alfalfa	1	1	0	0	0	0	0
<i>Non-priority species</i>		35	10	7	1	0	2	15
All species		195	44	74	46	14	2	15

*Infestation size classes: 1 = 1–a few plants ($\leq 2 \times 2$ m), 2 = few plants–40 m² (48 yd²), 3 = 40–400 m² (48–478 yd²), 4 = 400–1,000 m² (0.1–0.25 acre), 5 = 1,000–2,000 m² (0.25–0.5 acre).

**May not have been recorded by all observers.

Table 3-4. Number of monitoring transects where priority exotic plant species were detected (of total transects monitored on those routes) and mean percent cover (standard error) by monitoring route, Zion NP, June 8–13, 2012.

Scientific name	Common name	Northgate Peaks		Wildcat Canyon		Zion Scenic Drive		Oak Creek and Admin. Area		All areas	
		Detected (3)	Percent cover (SE)	Detected (13)	Percent cover (SE)	Detected (32)	Percent cover (SE)	Detected (5)	Percent cover (SE)	Detected (161)	Percent cover (SE)
<i>Melilotus officinalis</i> *	yellow sweetclover	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	2	0.07 (0.04)	2	0.002 (0.001)
<i>Poa bulbosa</i>	bulbous bluegrass	1	0.06 (0.06)	2	0.09 (0.08)	7	0.10 (0.04)	0	0.00 (0.00)	10	0.03 (0.01)

*Not a priority species, so may not have been recorded by all observers.

There were no invasives detected in transects on all routes not listed above.

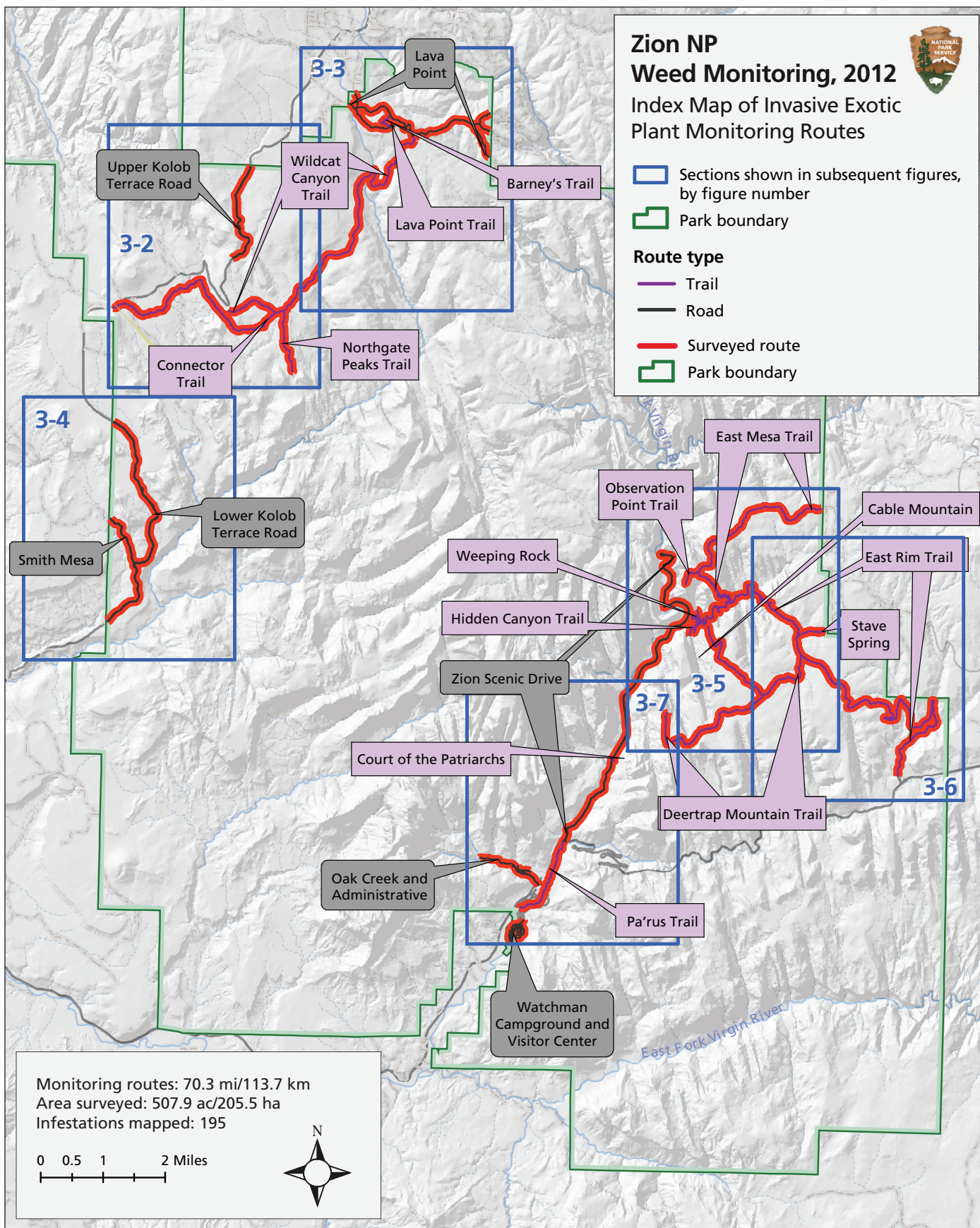


Figure 3-1. Index map of invasive plant monitoring routes by figure number, Zion National Park, June 8–13, 2012.

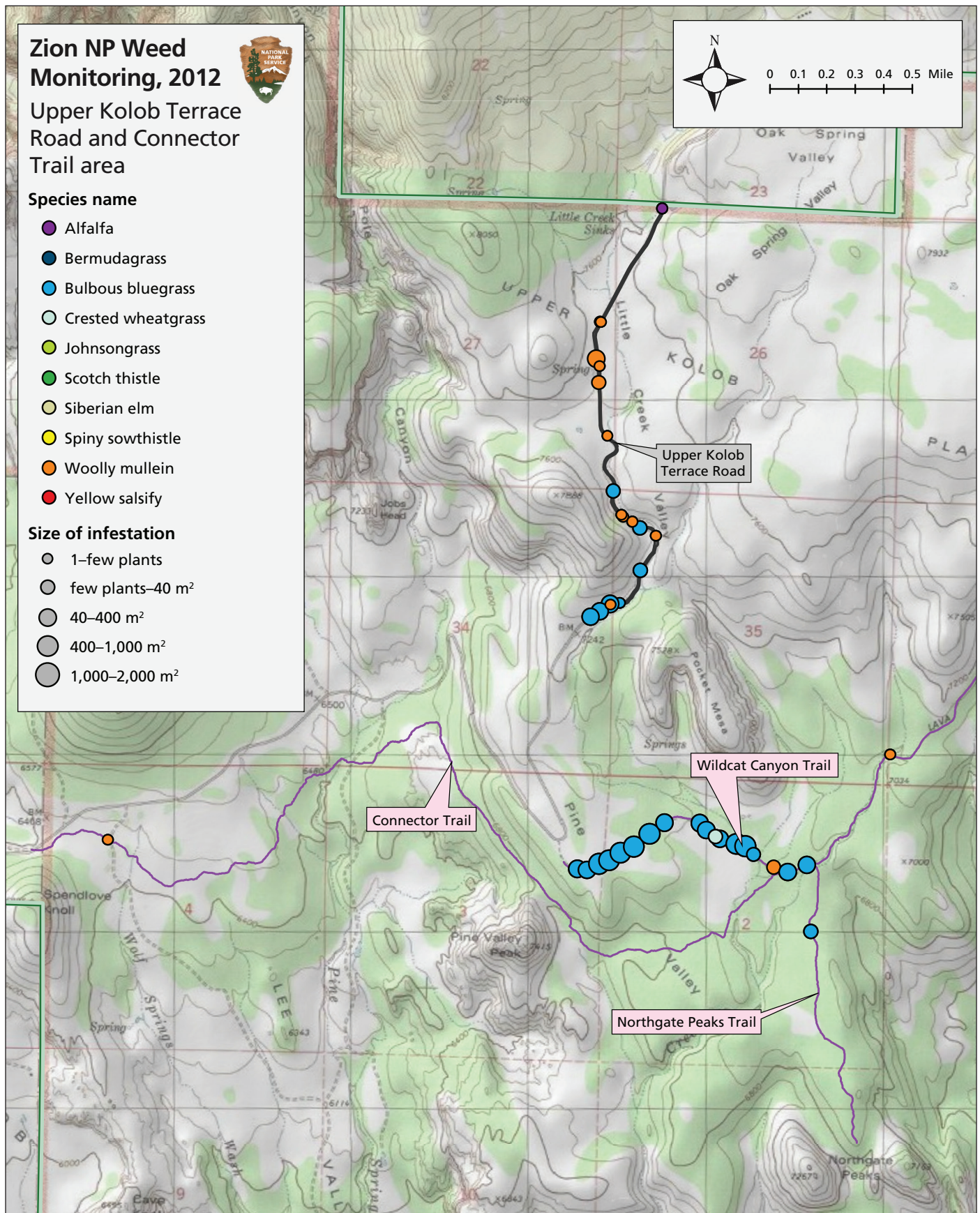


Figure 3-2. Invasive plants detected in the Upper Kolob Terrace Road and Connector Trail area, Zion National Park, June 8–13, 2012.

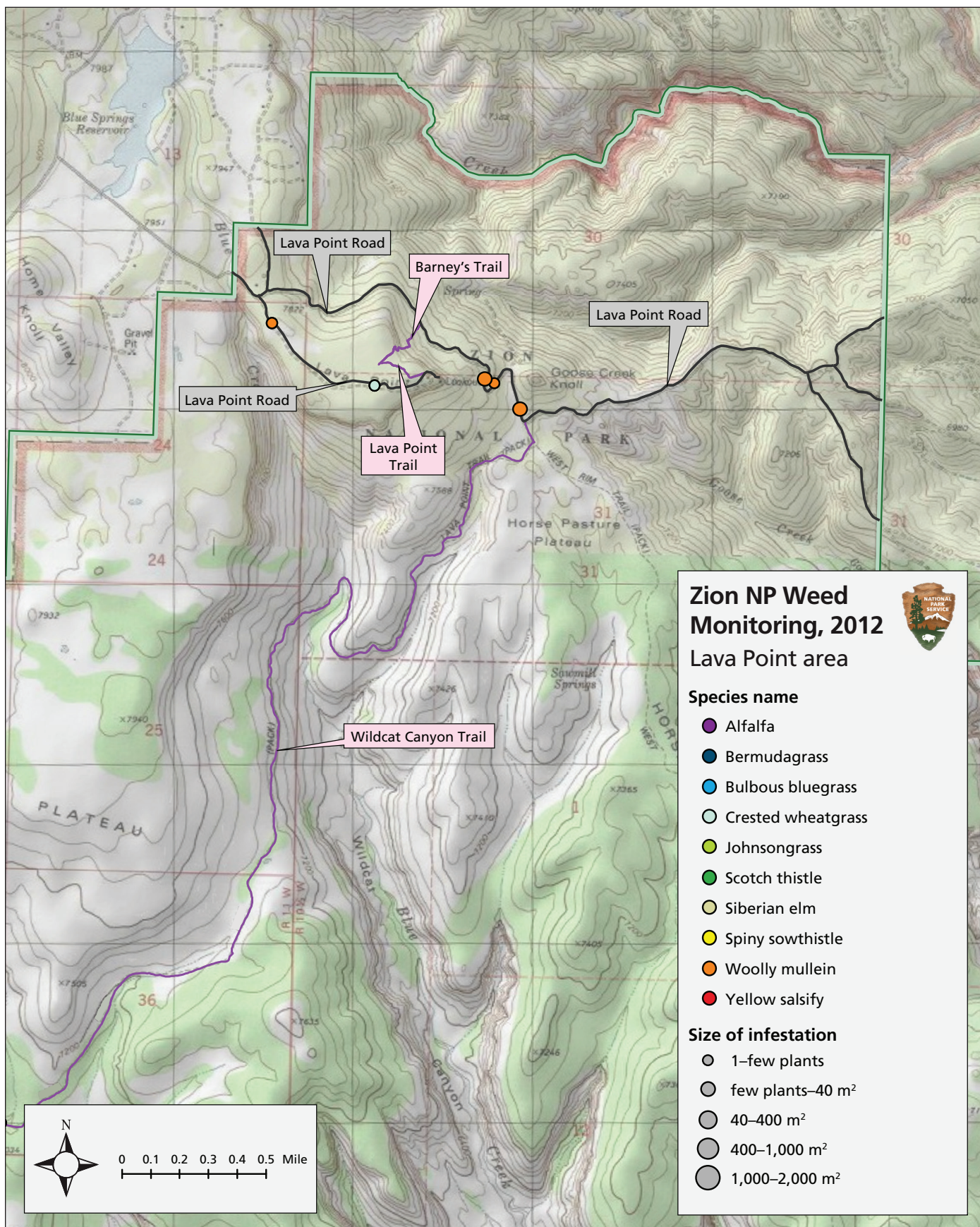


Figure 3-3. Invasive plants detected in the Lava Point area, Zion National Park, June 8–13, 2012.

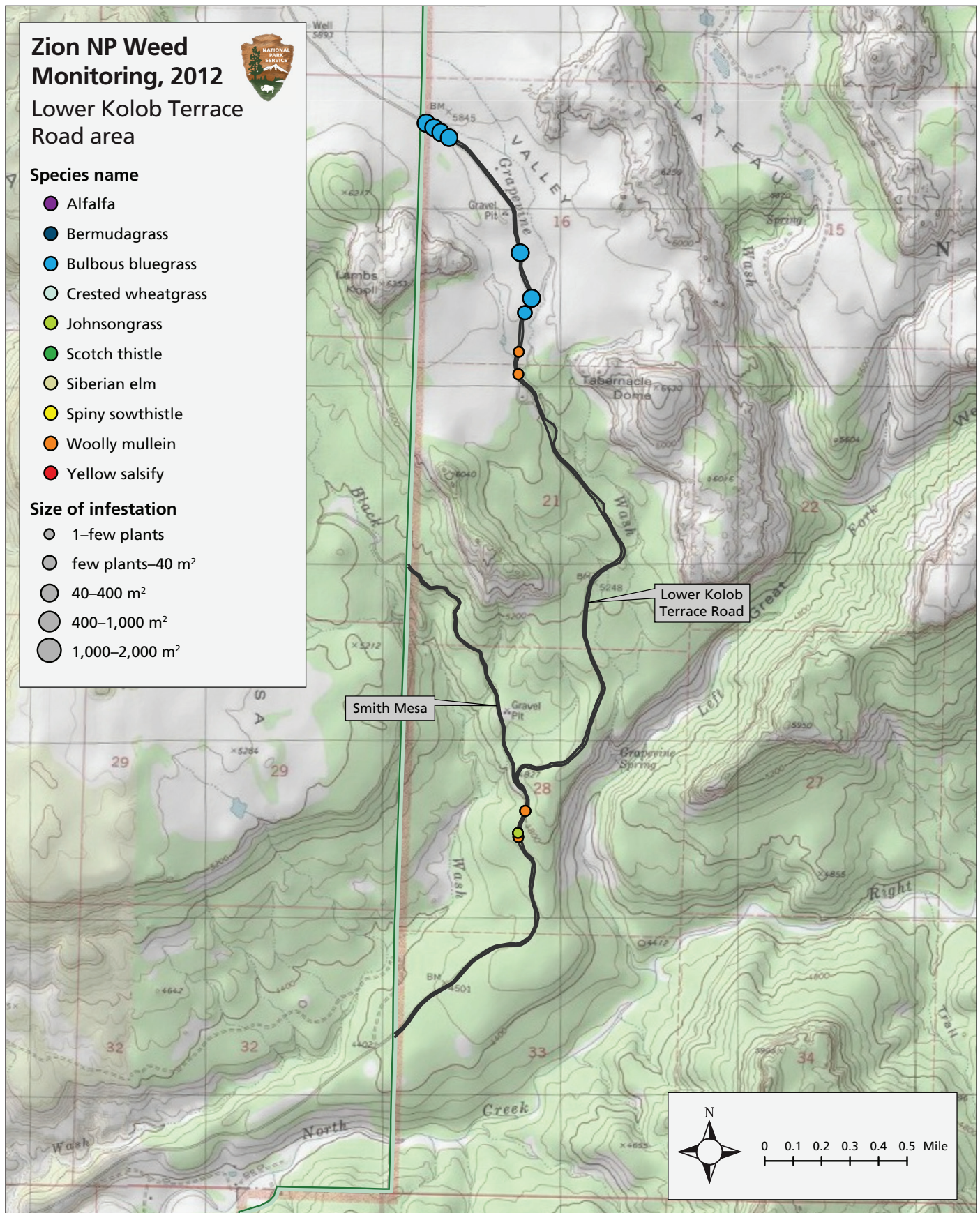


Figure 3-4. Invasive plants detected in the Lower Kolob Terrace Road area, Zion National Park, June 8–13, 2012.

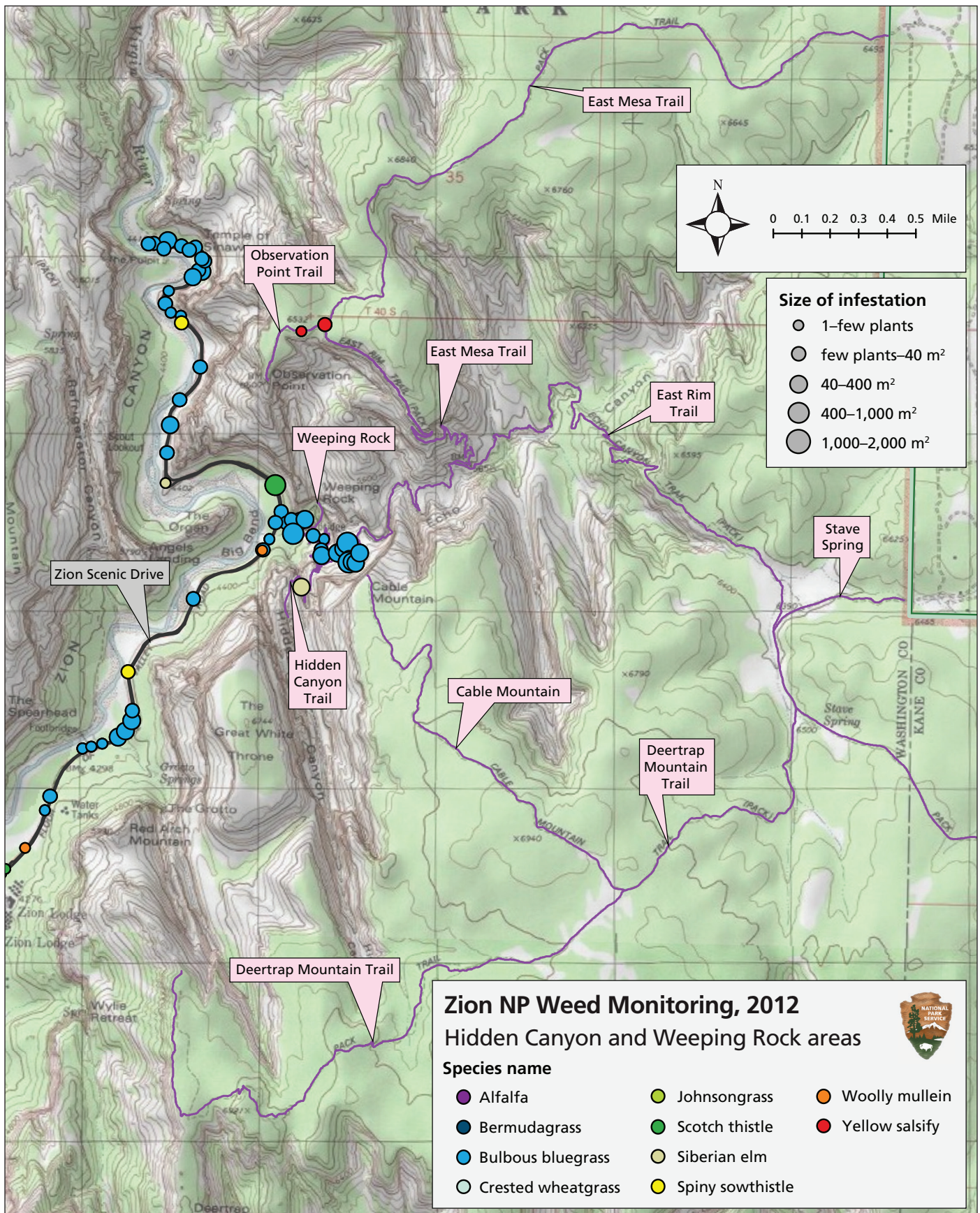


Figure 3-5. Invasive plants detected in the Hidden Canyon and Weeping Rock areas, Zion National Park, June 8–13, 2012.

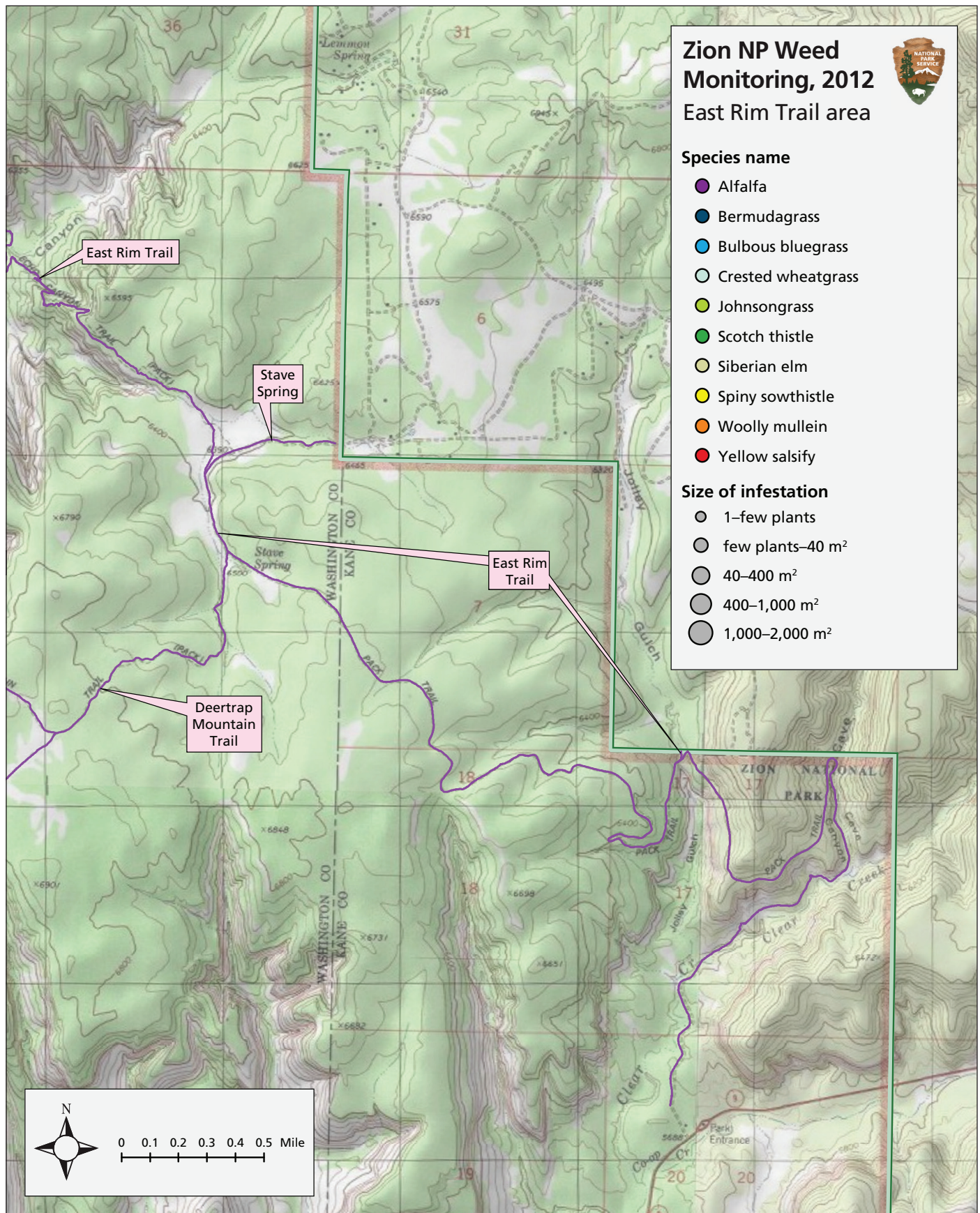


Figure 3-6. Invasive plants detected in the East Rim Trail area, Zion National Park, June 8–13, 2012.

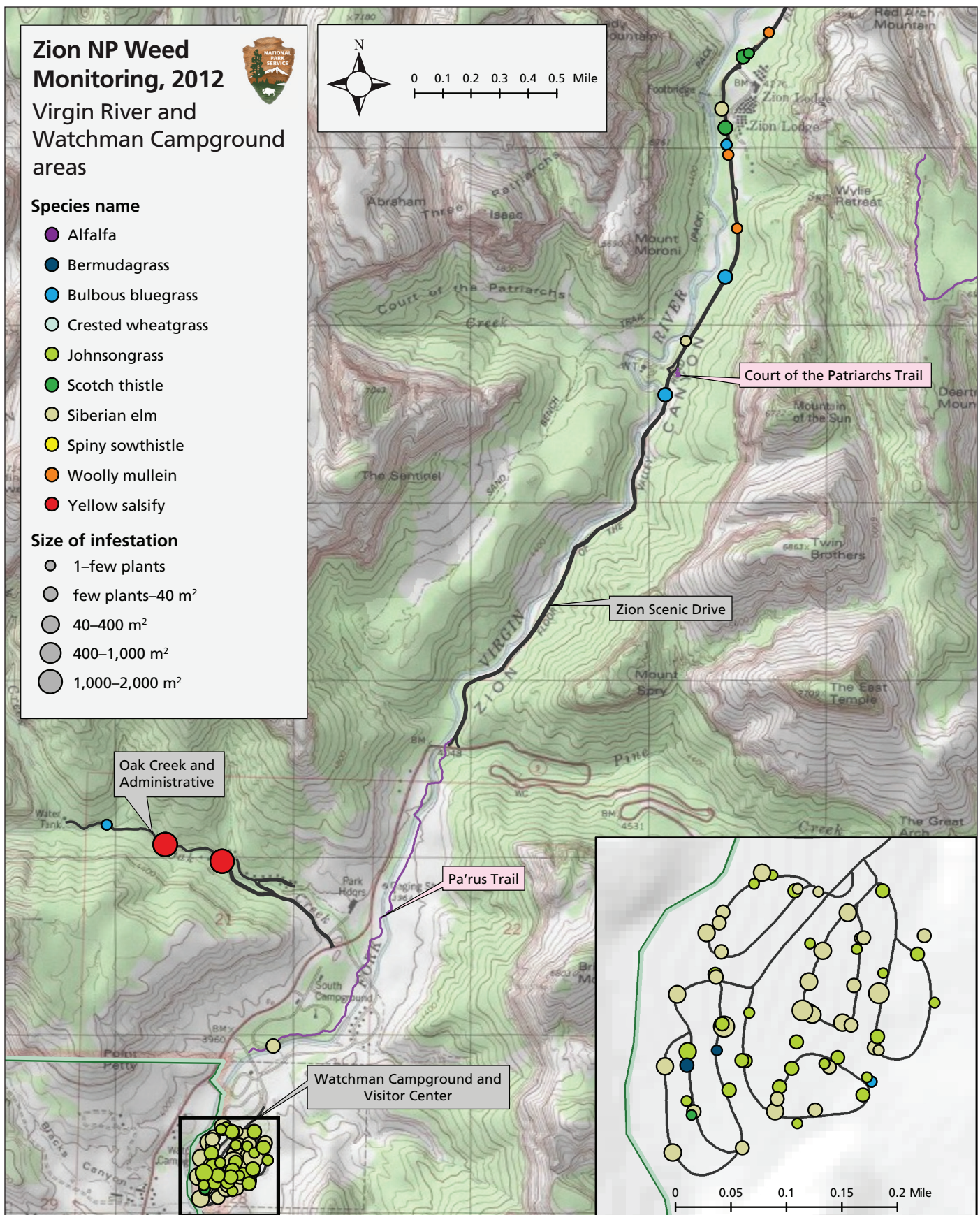


Figure 3-7. Invasive plants detected in the Virgin River and Watchman Campground areas, Zion National Park, June 8–13, 2012.

4 Discussion

4.1 Priority IEP List

The NCPN will continue to work with park staff and area weed experts to review and update the list of priority species each year. Park staff may want to consider adding woolly mullein to the priority list due to its widespread presence. Alternatively, it could be added as a species that is only recorded in transects if park staff thinks it is too widespread to be controlled. Presence and absence data for most priority species, and presence data for other species, should be reliable for the area surveyed; however, absence data for non-priority species are suspect, because not all observers recorded all of these species in all years.

4.2 Possibilities for management control

Bulbous bluegrass was the most widespread invasive plant (55% of priority infestations), but it is one that can be controlled with spring tilling, planting native grasses, or chemical control. Siberian elm, the second-most prevalent invasive species, can generally be controlled by cutting and girdling or hand-pulling seedlings. Johnson grass, the third-most common priority invasive plant, is considerably harder to control, and all efforts should be made to prevent its further establishment. Control methods can range from digging up small populations to using a wide range of integrated approaches on larger infestations.

Only 28% of priority infestations were larger than 40 m², indicating that control is still possible. Efforts should be made to control invasive plants in high-use visitor areas that tended to have the most invasive plants (Watchman Campground and Visitor Center, Zion Scenic Drive and Weeping Rock Trail).

It should also be noted that overall percent cover was very low and several monitoring routes had either few or no priority invasive plants (see Table 3-2). Efforts should be made to keep these areas weed-free. Estimates of percent cover in this report (see Table 3-4) are limited to the routes surveyed; actual percent cover of IEPs across the entire park cannot be inferred with these methods. Because we have chosen to monitor along areas most likely to be invaded by a broad suite of IEPs, it is plausible that the percent cover for most IEP species is lower in the interior of the park than along the monitoring routes.

4.3 Future monitoring efforts

IEPs at Zion NP will generally be monitored at the same time each year. Consistency in timing of monitoring should ensure consistency in detection probabilities and cover estimates of most species. For many species, sampling at any time from May through September is not expected to drastically alter the chances of detecting invasive species at a level larger than the minimum detection target size.

In 2013, the NCPN will expand monitoring efforts to new areas in the park (exact routes to be determined). We may also complete some extra-area surveys in locations yet to be determined. Because any previous detections could have been eradicated by park staff, the locations of monitoring quadrats are re-generated each year. Long-term trend reporting will focus on trends in species distributions, trends in percent cover of individual species, and changes in IEP percent cover of priority species by monitoring route. Peer review comments on the NCPN invasive plant monitoring protocol were received in September 2012. It is expected that the protocol will be finalized in Fiscal Year 2013.

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