



Invasive Exotic Plant Monitoring in Zion National Park

2015 Field Season

Natural Resource Report NPS/NCPN/NRR—2016/1258



ON THE COVER

South Campground, Zion National Park. NPS photo.

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Executive Summary

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 17–24, 2015, NCPN staff detected 108 patches of 14 IEP species (eight of which were priority species) along 155.0 kilometers of monitoring routes and transects at Zion National Park. Scotch thistle (*Onopordum acanthium*), little bur-clover (*Medicago minima*), Bermudagrass (*Cynodon dactylon*), Johnsongrass (*Sorghum halepense*), and Siberian elm (*Ulmus pumila*) were the most commonly detected priority invasive plants. The highest numbers of priority infestations were found at the Watchman Campground and Visitor Center area (4.55 infestations/km), Watchman Housing Area (2.18/km), South Campground and Nature Center (1.94/km), Oak Creek and Administrative area (1.79/km), and Visitor Center Trails (Archaeology, Museum, Pa’rus, and Watchman) (1.18/ km). Roads generally had higher patch densities than trails. Several trails were free of priority IEP patches. IEPs were found on 184 transects (62%), with an average of 0.66 IEP species detected per plot. However, almost all of these detections were cheatgrass (*Bromus tectorum*). Cheatgrass was widespread—present in 62% of transects and with an estimated cover of 0.77% across all transects sampled. Cheatgrass cover was as high as 2.04% along the Zion Scenic Drive and 1.92% along the Sand Bench Trail. In areas that were sampled in 2012–2013 and 2015, declines in Johnsongrass, bulbous bluegrass (*Poa bulbosa*), and Siberian elm were observed. These declines were seen along the Kolob Terrace Road and in the Main Canyon. A more complete analysis will be completed after the 2016 field season completes the second full rotation of routes at Zion National Park.

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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 (Loope 1992). 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 2015 field season at Zion National Park (NP).

2 Methods

We followed the invasive exotic plant monitoring protocol developed by the NCPN (Perkins et al. 2013), 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 (Table 2-1). The list was developed by reviewing past park literature and state and county weed lists, and consulting with park staff and county weed managers. The 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 IEP 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.

Table 2-1. Priority invasive plant list, Zion NP, 2012–2015.

Scientific name	Common name
<i>Alhagi maurorum</i>	camelthorn
<i>Bassia scoparia</i> ¹	summer cypress
<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 virgata</i> ²	squarrose knapweed
<i>Chrysanthemum vulgare</i> ³	ox-eye daisy
<i>Cirsium arvense</i>	Canada thistle
<i>Conium maculatum</i>	poison hemlock
<i>Cynodon dactylon</i>	Bermudagrass
<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>Lepidium latifolium</i>	broad-leaf pepperwort
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Linaria vulgaris</i>	butter-and-eggs
<i>Lythrum salicaria</i>	purple loosestrife
<i>Medicago minima</i> ⁴	little bur-clover
<i>Onopordum acanthium</i>	Scotch thistle
<i>Poa bulbosa</i>	bulbous bluegrass
<i>Potentilla recta</i>	sulfur cinquefoil
<i>Sorghum halepense</i>	Johnsongrass
<i>Taeniatherum caput-medusae</i>	Medusahead
<i>Ulmus pumila</i>	Siberian elm

¹Listed as *Kochia scoparia* (kochia) in the 2012 report.

²Listed as *Centaurea squarrosa* in the 2012 and 2013 reports.

³Listed as *Leucanthemum vulgare* in the 2012 and 2013 reports.

⁴Added to target list in 2015.

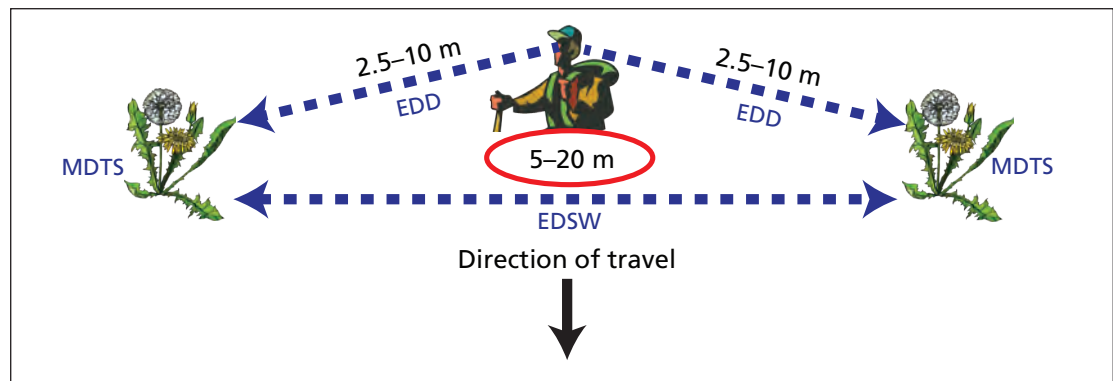


Figure 2-1. The maximum effective detection distance (EDD) at Zion National Park ranged from 2.5 to 10 meters, making the effective detection swath width (EDSW) 5–20 meters.

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 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 2015 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 IEPs for one EDD on either side of his/her search route. The EDSW ranged from 5 to 20 m at Zion NP in 2015.

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. 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. 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 patch during planning and implementation of IEP-control operations. If a patch 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 patch.

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

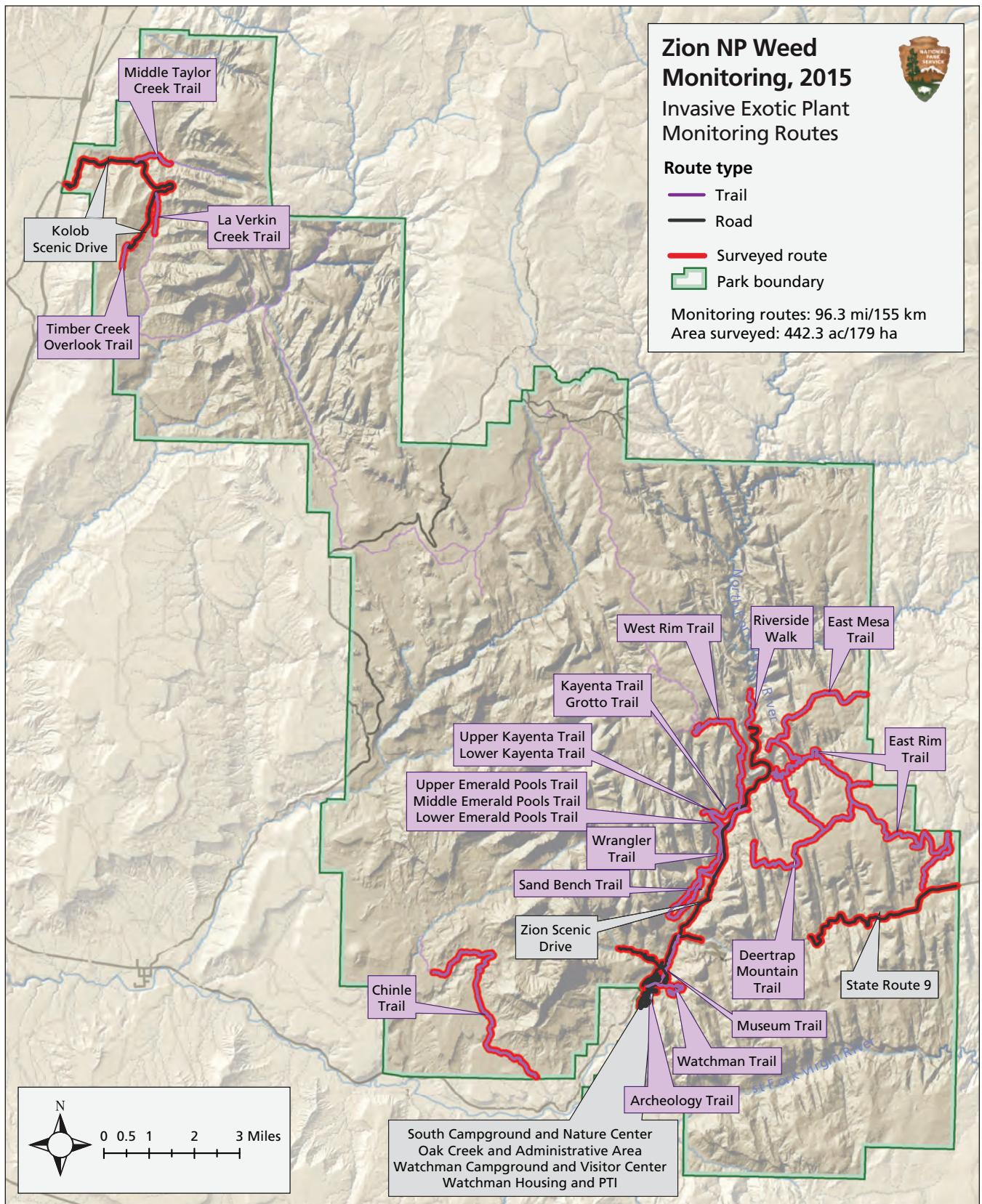


Figure 2-2. Overview of invasive plant monitoring routes surveyed at Zion NP, June 17–24, 2015.

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) patch 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, then we recorded a point for each individual species and assigned it its own sequential identification number. Invasions more than 50 m (55 yards) apart were considered separate invasions and recorded with separate points. Patch 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 patch: 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 to 2-6).

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 patches per kilometer 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.



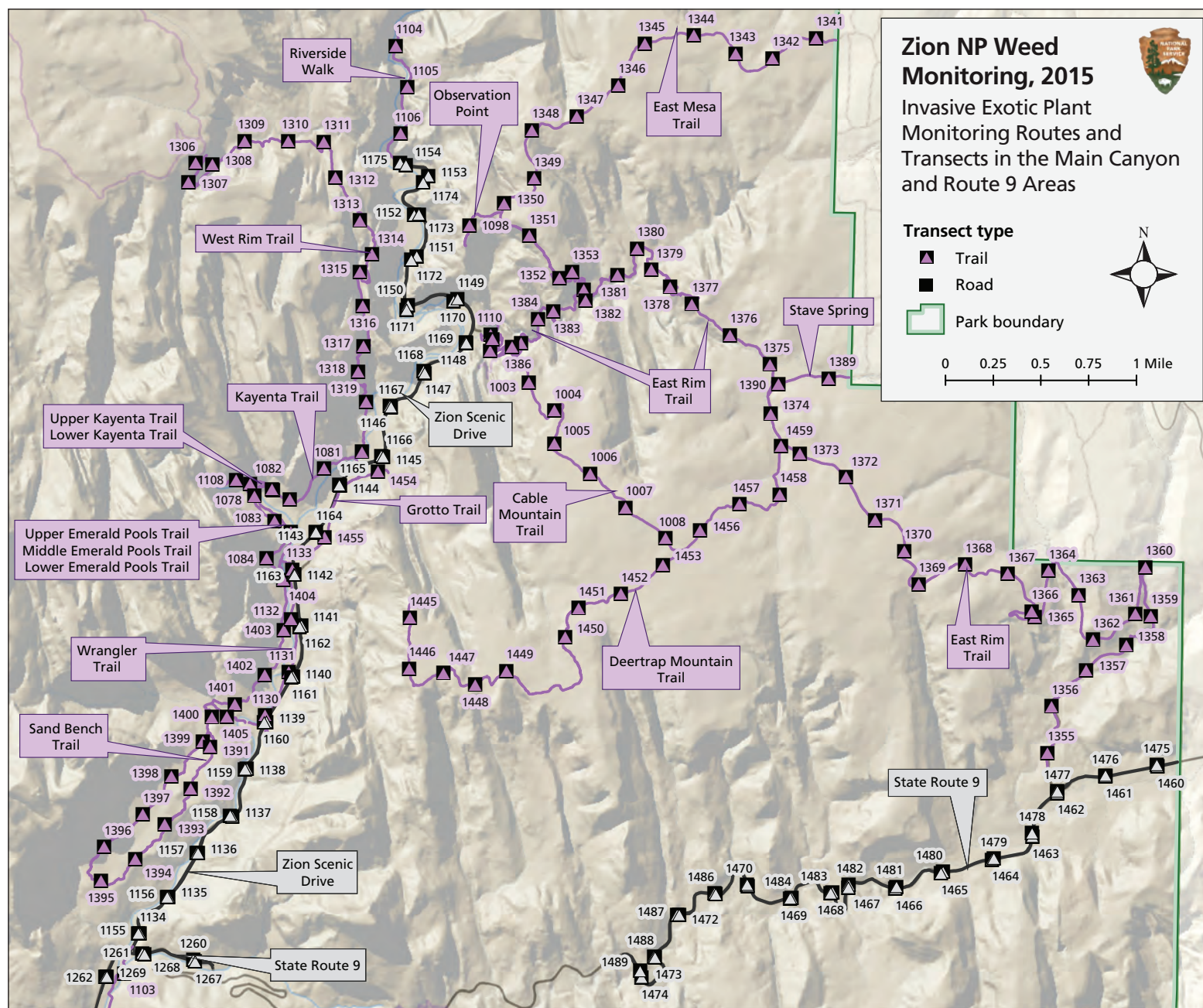


Figure 2-4. Monitoring routes and transects in the main canyon and Route 9 areas, Zion NP, June 17–24, 2015.

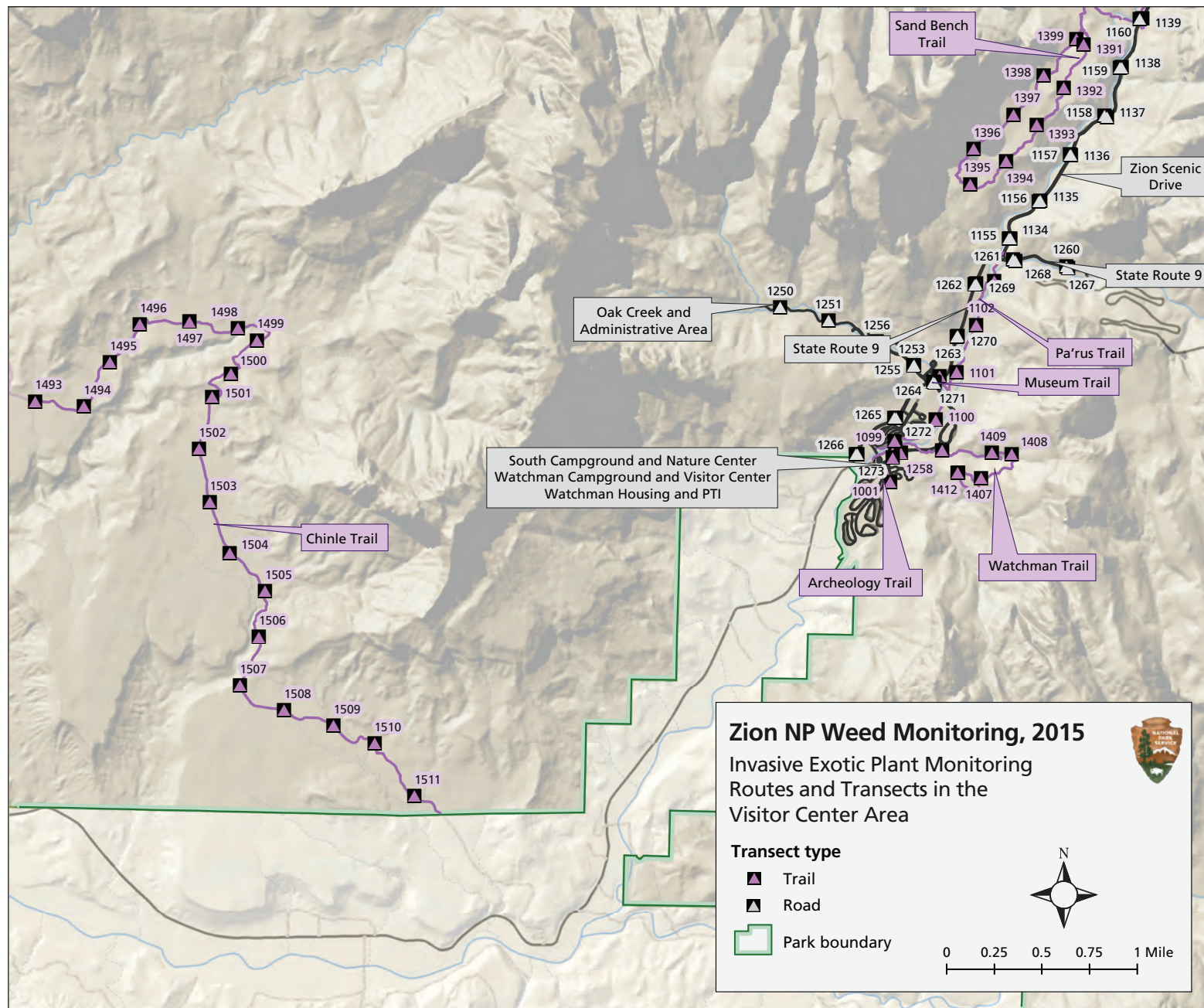


Figure 2-5. Monitoring routes and transects in the visitor center area, Zion NP, June 17–24, 2015.

3 Results

3.1 Target invasive exotic plant list

Thirty IEP species were identified as priority on the Zion NP target list for 2015 (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. In addition, two species, cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola tragus*), were recorded consistently in transects, but not mapped along routes by all observers in 2015. This procedure will continue in future years.

We recorded a total of eight priority IEP species on monitoring routes and three priority IEP species on transects in 2015 (Table 3-1). Four and two additional non-priority species were recorded on routes and transects, respectively. We covered 155 km (96.3 miles) of monitoring routes in 2015 and mapped 108 invasive patches.

3.2 Monitoring routes

A total of 99 patches of eight different priority IEP species were detected along monitoring

routes in 2015 (Table 3-2; Figures 3-1 to 3-8; Appendix A). The most common priority invasive species (Table 3-3) were Scotch thistle (*Onopordum acanthium*), little bur-clover (*Medicago minima*), Bermudagrass (*Cynodon dactylon*), and Johnsongrass (*Sorghum halepense*). These four species represented 79% of the priority infestations found.

The Watchman Campground and Visitor Center area had the highest number of priority patches (4.55/km) of any route (see Table 3-2). The Visitor Center Trails (Archaeology, Museum, Pa'rus, and Watchman trails) had the highest infestation density of any trail route (1.18/km). The Watchman Housing Area, South Campground and Nature Center, and Oak Creek and Administrative area had the next-highest IEP densities, at 2.18, 1.94, and 1.79 patches/km, respectively. All other routes had less than one priority patch per kilometer. Roads generally had higher patch densities than trails. Several trails were free of priority IEP patches.

Of the 99 patches, 28% were larger than 40 m² (Table 3-3). Siberian elm and tamarisk were the only exotic tree species detected. Of the 17 tree infestations, 4 were seedlings, 8 were in the sapling stage, and 5 were mature trees (see Appendix A).

Table 3-1. Invasive exotic plants detected at Zion NP, June 17–24, 2015.

Scientific name	Common name	Method detected		Priority?
		Route	Transect	
<i>Bassia scoparia</i>	summer cypress	X		Yes
<i>Cynodon dactylon</i>	Bermudagrass	X	X	Yes
<i>Medicago minima</i>	little bur-clover	X	X	Yes
<i>Onopordum acanthium</i>	Scotch thistle	X		Yes
<i>Sorghum halepense</i>	Johnsongrass	X		Yes
<i>Taeniatherum caput-medusae</i>	Medusahead	X		Yes
<i>Ulmus pumila</i>	Siberian elm	X		Yes
<i>Poa bulbosa</i>	bulbous bluegrass	X	X	Yes
<i>Aegilops cylindrica</i>	jointed goatgrass	X		No
<i>Agropyron cristatum</i>	crested wheatgrass	X		No
<i>Bromus tectorum</i>	cheatgrass		X	No
<i>Marrubium vulgare</i>	common horehound	X		No
<i>Salsola tragus</i>	Russian thistle		X	No
<i>Tamarix</i> sp.	tamarisk	X		No

3.3 Monitoring transects

A total of 295 transects were sampled in 2015 (Table 3-4; see Figures 2-3 to 2-5; Appendix B). IEPs were found on 184 transects (62%), with an average of 0.66 IEP species detected per plot. Five IEP species were detected: cheatgrass, Russian thistle, and the priority species little bur-clover, bulbous bluegrass (*Poa bulbosa*), and Bermudagrass. Priority species were only found in <1% of transects, with an average of 0.02 priority IEP species per transect.

Cheatgrass had the highest percent cover, with 2.04%, 1.92%, 0.98%, and 0.66% along the Zion Scenic Drive, Sand Bench Trail, State Route 9, and Main Canyon Trails, respectively. Cheatgrass was widespread, as it was present in 60% of the transects sampled in 2015. It was present in 71%, 80%, and 84% of transects along the Zion Scenic Drive, Sand Bench Trail, and State Route 9, respectively. Bermudagrass, little bur-clover, and bulbous bluegrass all had <0.1 mean percent cover.

3.4 Results comparison: 2012–2013 to 2015

From 2012 to 2013, Perkins (2013; 2014) surveyed the same areas of Zion NP with

the same methods used in 2015. Since then, patches per kilometer have declined in most areas in the Main Canyon, most notably on the Zion Scenic Drive (-80%), and the Central Trails (-83%) (Table 3-5). Siberian elm, Johnsongrass, and bulbous bluegrass were primarily responsible for the declines. Only Bermudagrass increased in between these two time periods (Table 3-6). While there were only a few infestations in 2012–2013, invasives were not detected in 2015 along the Riverside Walk, Sand Bench Trail, and Weeping Rock Trail.

Patches increased at only two areas in the Main Canyon: the Oak Creek and Administrative area increased by 179% and the Visitor Center Trails increased by 247% (see Table 3-5). However, in both of these cases, the numbers were based on small routes and small numbers of patches (3 and 15 total patches in 2012–2013 and 2015, respectively), making the percent change appear large.

In transects, cheatgrass was, by far, the most frequently detected species in both sample periods, though it appears to have declined on the Main Canyon Trails and State Route 9 (Table 3-7).

Table 3-2. Number of IEP patches and patches/ha by route and route type, Zion NP, June 17–24, 2015.

Route	Length (m)	Area (ha)	Patches		Patches/km	
			Total	Priority only	Total	Priority only
Roads						
Kolob Scenic Drive	17,410.93	15.73	11	9	0.63	0.52
Oak Creek & Administrative	4,460.44	4.78	9	8	0.50	1.79
S. Campground & Nature Ctr.	3,606.41	3.29	7	7	0.52	1.94
State Route 9	21,379.01	19.28	16	15	0.75	0.70
Watchman CG and VC	4,837.13	4.73	22	22	4.55	4.55
Watchman Housing & PTI*	4,137.26	3.05	9	9	2.18	2.18
Zion Scenic Drive	20,505.78	20.78	13	12	0.63	0.59
All roads	76,336.98	71.63	87	82	1.14	1.07
Trails						
Cable Mountain	2,888.82	4.32	0	0	0	0.00
Central Trails ¹	3,231.16	5.70	3	1	0.93	0.31
Chinle	9,532.75	19.01	1	0	0.10	0.00
Deertrap Mountain	6,975.12	13.84	1	0	0.14	0.00
East Mesa/Observation Pt.	7,637.00	5.31	0	0	0	0.00
East Rim/Stave Spring	17,771.59	21.77	5	5	0.28	0.28
Emerald Pools Trails	3,085.38	3.11	4	4	1.29	1.29
Kayenta Trails	1,467.24	1.42	0	0	0	0.00
Northern Trails ²	4,162.91	4.69	0	0	0	0.00
Riverside Walk	1,557.90	3.11	0	0	0	0.00
Sand Bench	7,019.35	10.44	0	0	0	0.00
Weeping Rock	297.77	0.35	0	0	0	0.00
West Rim	7,076.83	6.92	0	0	0	0.00
Visitor Center Trails ³	5,930.22	7.38	7	7	1.18	1.18
All trails	78,634.06	107.37	21	17	0.27	0.22

*Shuttle staging area for Parks Transportation, Inc.

¹Grotto, Wrangler, and Court of the Patriarch Trails

²La Verkin, Middle Taylor Creek, and Timber Creek Overlook Trails

³Archaeology, Museum, Pa'rus, and Watchman Trails

Table 3-3. Number of patches by species and patch size class detected along monitoring routes, Zion NP, June 17–24, 2015.

Scientific name	Common name	Total patches	Patch size class*				
			1	2	3	4	5
Priority species							
<i>Bassia scoparia</i>	summer cypress	1	0	1	0	0	0
<i>Cynodon dactylon</i>	Bermudagrass	19	4	7	2	1	5
<i>Medicago minima</i>	little bur-clover	22	4	13	4	1	0
<i>Onopordum acanthium</i>	Scotch thistle	22	11	8	2	1	0
<i>Poa bulbosa</i>	bulbous bluegrass	7	3	1	3	0	0
<i>Sorghum halepense</i>	Johnsongrass	15	5	6	4	0	0
<i>Taeniatherum caput-medusae</i>	Medusahead	1	0	1	0	0	0
<i>Ulmus pumila</i>	Siberian elm	12	4	3	1	3	1
Total priority species		99	31	40	16	6	6
Non-priority species							
<i>Aegilops cylindrica</i>	jointed goatgrass	1	0	0	1	0	0
<i>Agropyron cristatum</i>	crested wheatgrass	1	0	1	0	0	0
<i>Marrubium vulgare</i>	common horehound	2	1	1	0	0	0
<i>Tamarix</i> sp.	tamarisk	5	2	1	1	1	0
Total non-priority species		9	3	3	2	1	0
Total species		108	34	43	18	7	6

*Patch 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).

Table 3-4. Number of transects where exotic plant species were detected/total transects monitored, mean percent cover, and standard error along monitoring routes, Zion NP, June 17–24, 2015.

Route	<i>Salsola tragus</i> (Russian thistle)		<i>Bromus tectorum</i> (cheatgrass)		Priority species*	
	Detected/ Total	Percent cover (SE)	Detected/ Total	Percent cover (SE)	Detected/ Total	Percent cover (SE)
Chinle Trail	0/19	0.00 (0.00)	11/19	0.15 (0.04)	11/19	0.15 (0.04)
East Mesa/Observation Pt.	0/15	0.00 (0.00)	5/15	0.08 (0.03)	5/15	0.08 (0.03)
Eastern Trails ¹	0/55	0.00 (0.00)	27/55	0.37 (0.09)	27/55	0.37 (0.09)
Kolob Scenic Drive	2/36	0.01 (0.01)	26/36	0.35 (0.12)	28/36	0.36 (0.12)
Main Canyon Trails ²	4/44	0.83 (0.76)	23/44	0.66 (0.26)	27/44	1.51 (0.79)
Northern Trails ³	0/10	0.00 (0.00)	2/10	0.07 (0.18)	2/10	0.21 (0.18)
Sand Bench	0/15	0.00 (0.00)	12/15	1.92 (0.96)	12/15	1.92 (0.96)
State Route 9	7/44	0.10 (0.07)	37/44	0.98 (0.23)	38/44	1.08 (0.23)
West Rim	0/15	0.00 (0.00)	3/15	0.09 (0.07)	3/15	0.09 (0.07)
Zion Scenic Drive	1/42	<0.01 (<0.01)	30/42	2.04 (0.90)	31/42	2.08 (0.90)
All transects	14/295	0.14 (0.11)	176/295	0.77 (0.15)	184/295	0.91 (0.19)

*The priority species little bur-clover, bulbous bluegrass, and Bermudagrass accounted for only five of the 196 IEP occurrences in plots.

¹Cable Mountain, Deertrap Mountain, East Rim and Stave Spring Trails

²Archeology, Grotto, Kayenta, Lower Emerald Pools, Lower Kayenta, Middle Emerald Pools, Museum, Oak Creek and Administrative, Pa'rus, Riverside Walk, Upper Emerald Pools, Upper Kayenta, Watchman Housing and PTI, Watchman, Weeping Rock and Wrangler Trails

³La Verkin, Middle Taylor Creek and Timer Creek Overlook Trails

Table 3-5. Patches/km on routes surveyed in 2012–2013 and 2015 with the same priority species, Zion NP.

Route	Patches/km		Percent change
	2012–2013	2015	
Roads			
Kolob Scenic Drive	1.03	0.46	-55%
Oak Creek & Administrative	0.48	1.34	+179%
S. Campground & Nature Ctr.	3.05	1.94	-36%
State Route 9	0.33	0.14	-57%
Watchman CG and VC	16.46	4.55	-72%
Watchman Housing & PTI*	3.43	2.18	-36%
Zion Scenic Drive	2.19	0.44	-80%
Trails			
Cable Mountain	0.00	0.00	NA
Central Trails ¹	1.88	0.31	-83%
Chinle	0.00	0.00	NA
Deertrap Mountain	0.00	0.00	NA
East Mesa/Observation Pt.	0.00	0.00	NA
East Rim/Stave Spring	0.74	0.28	-58%
Emerald Pools Trails	0.00	0.65	+++
Kayenta Trails	0.00	0.00	NA
Northern Trails	0.00	0.00	NA
Riverside Walk	1.28	0.00	-100%
Sand Bench	0.14	0.00	-100%
Weeping Rock	13.43	0.00	-100%
West Rim	0.00	0.00	NA
Visitor Center Trails ²	0.34	1.18	+247%

¹Grotto, Wrangler, and Court of the Patriarch Trails

²Archaeology, Museum, Pa'rus, and Watchman Trails

*Shuttle staging area for Parks Transportation, Inc.

Table 3-6. Number of patches by species and patch size class detected along monitoring routes monitored in 2012–2013 and 2015, Zion NP.

Scientific name	Common name	Year	Total patches	Patch size class*				
				1	2	3	4	5
<i>Bassia scoparia</i>	summer cypress	2012–2013	2	0	1	1	0	0
		2015	1	0	1	0	0	0
<i>Cynodon dactylon</i>	Bermudagrass	2012–2013	12	3	3	3	1	2
		2015	19	4	7	2	1	5
<i>Onopordum acanthium</i>	Scotch thistle	2012–2013	27	16	7	2	2	0
		2015	22	11	8	2	1	0
<i>Poa bulbosa</i>	bulbous bluegrass	2012–2013	68	13	30	22	3	0
		2015	7	3	1	3	0	0
<i>Sorghum halepense</i>	Johnsongrass	2012–2013	31	14	16	1	0	0
		2015	15	5	6	4	0	0
<i>Taeniatherum caput-medusae</i>	Medusahead	2012–2013	0	0	0	0	0	0
		2015	1	0	1	0	0	0
<i>Ulmus pumila</i>	Siberian elm	2012–2013	64	18	26	16	4	0
		2015	12	4	3	1	3	1
Total priority species		2012–2013	204	64	83	45	10	2
		2015	77	27	27	12	5	6

*Patch 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).

Table 3-7. Percent cover of cheatgrass and all other species monitored in transects in 2012–2013 and 2015, Zion NP.

Route	Year	<i>Bromus tectorum</i> (cheatgrass)		All other species	
		Detected/Total	Percent cover (SE)	Detected/Total	Percent cover (SE)
Chinle Trail	2012–2013	6/11	0.12 (0.04)	6/11	0.12 (0.04)
	2015	11/19	0.15 (0.04)	11/19	0.15 (0.04)
Main Canyon Trails ¹	2012–2013	15/22	2.73 (1.33)	15/22	2.73 (1.33)
	2015	23/44	0.66 (0.26)	27/44	1.51 (0.79)
Sand Bench	2012–2013	13/14	4.76 (2.28)	13/14	4.76 (2.28)
	2015	12/15	1.92 (0.96)	12/15	1.92 (0.96)
State Route 9	2012–2013	33/39	1.96 (0.40)	33/39	1.96 (0.40)
	2015	37/44	0.98 (0.23)	38/44	1.08 (0.23)

¹Archeology, Grotto, Kayenta, Lower Emerald Pools, Lower Kayenta, Middle Emerald Pools, Museum, Oak Creek and Administrative, Pa'rus, Riverside Walk, Upper Emerald Pools, Upper Kayenta, Watchman Housing and PTI, Watchman, Weeping Rock and Wrangler Trails

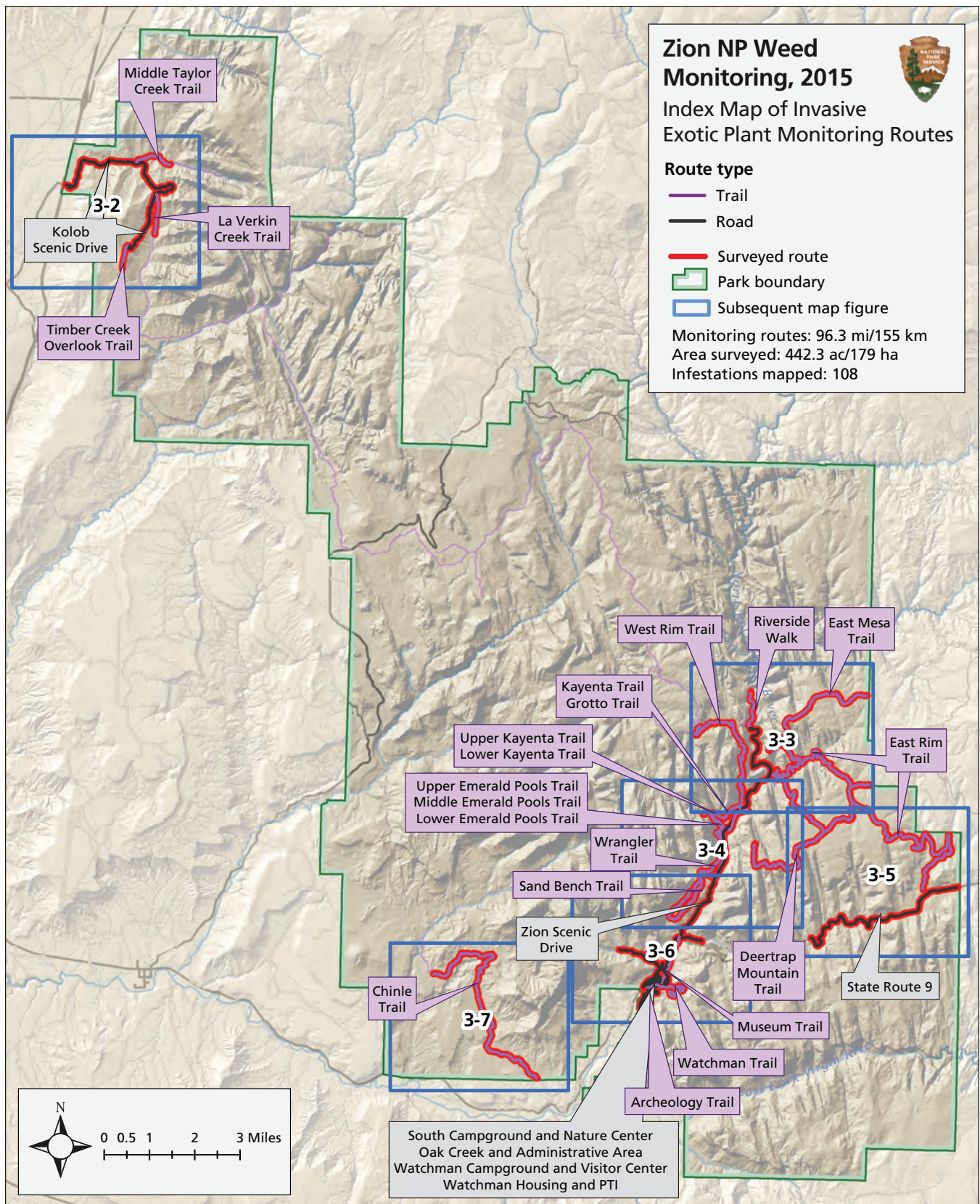


Figure 3-1. Index map of invasive plant monitoring routes by figure number, Zion National Park, June 17–24, 2015.

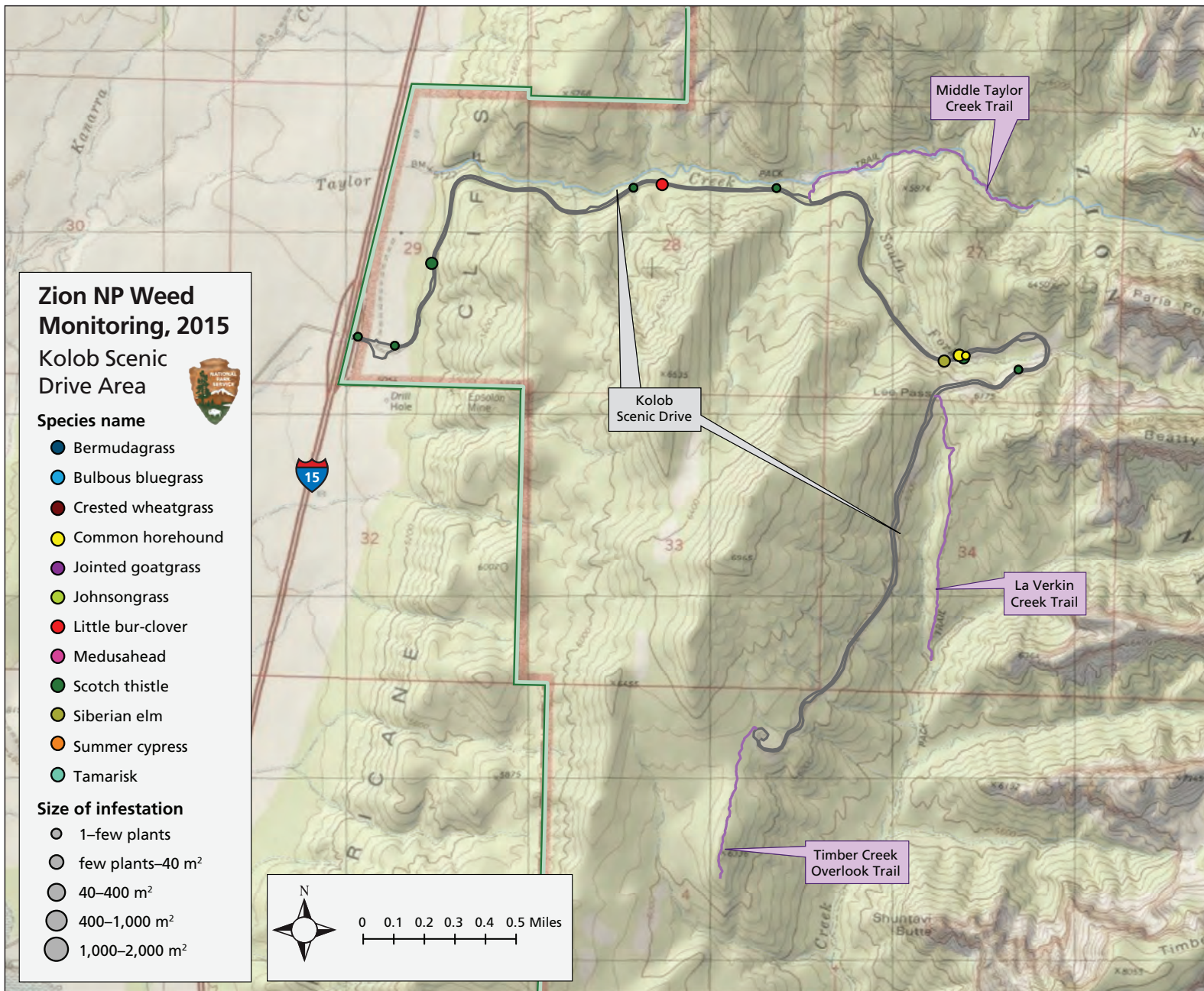


Figure 3-2. Invasive plants detected on monitoring routes in the Kolob Scenic Drive area, Zion National Park, June 17–24, 2015.

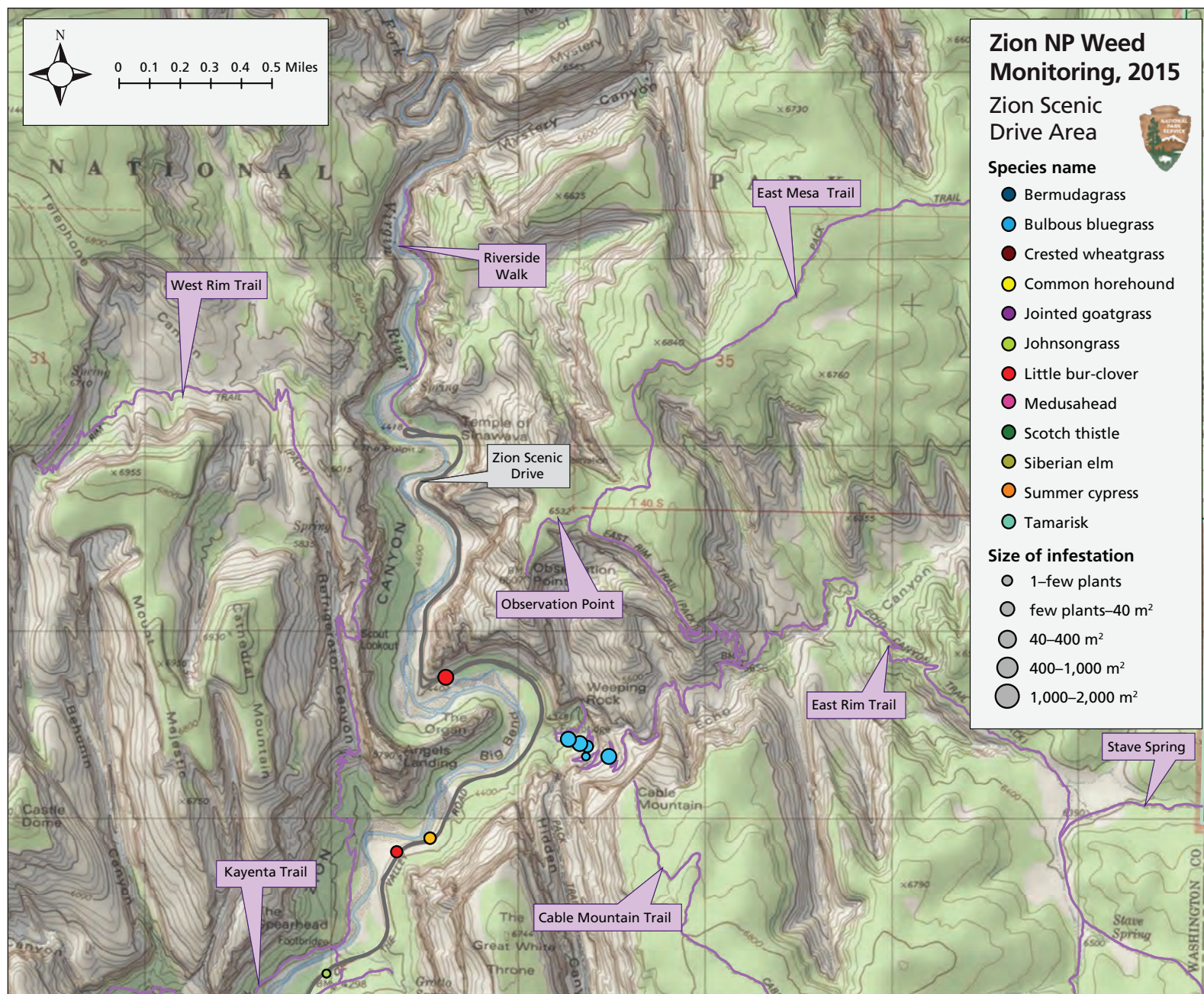


Figure 3-3. Invasive plants detected on monitoring routes on the Zion Scenic Drive and surrounding area, Zion National Park, June 17–24, 2015.

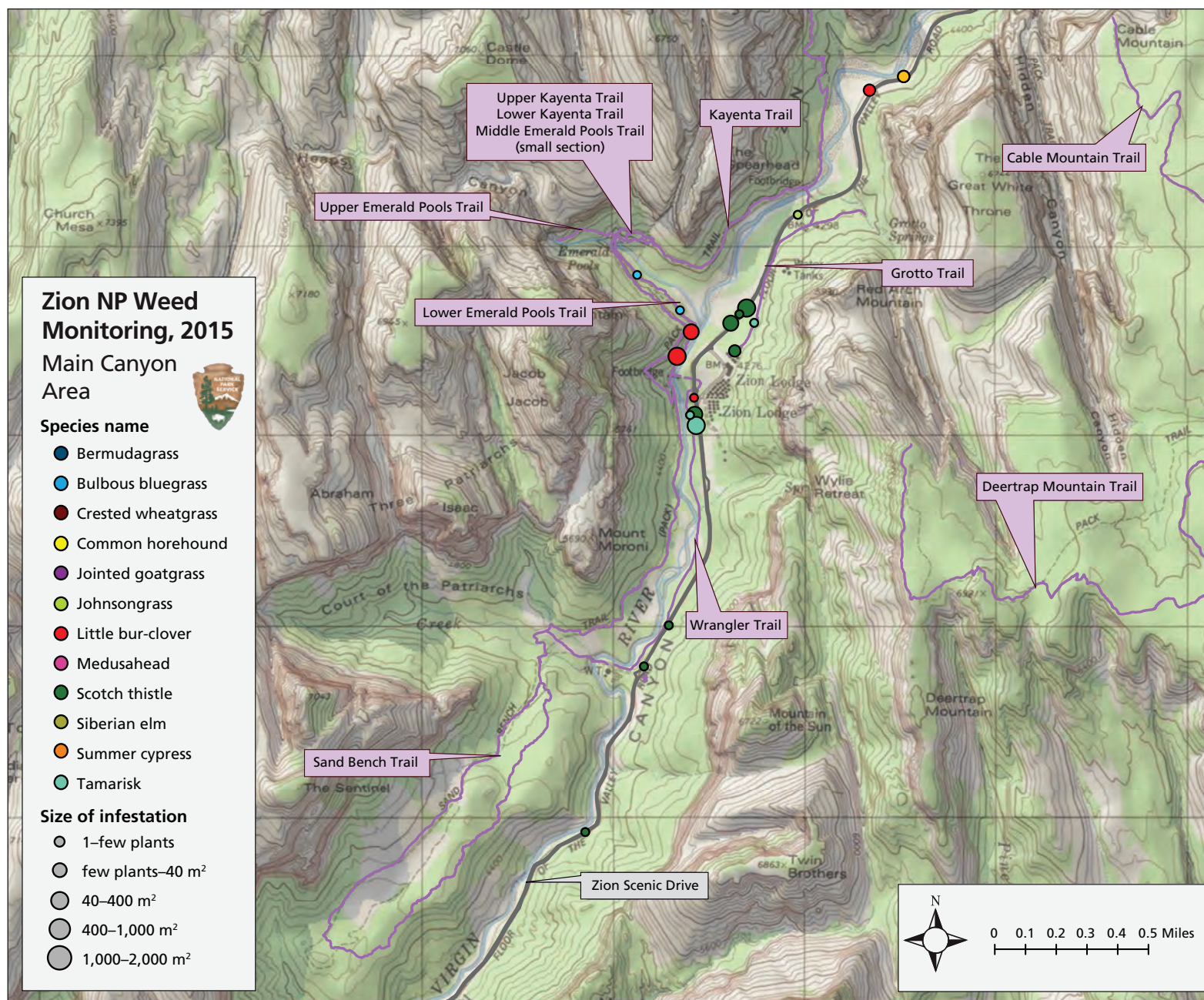


Figure 3-4. Invasive plants detected on monitoring routes in the main canyon area, Zion National Park, June 17–24, 2015.

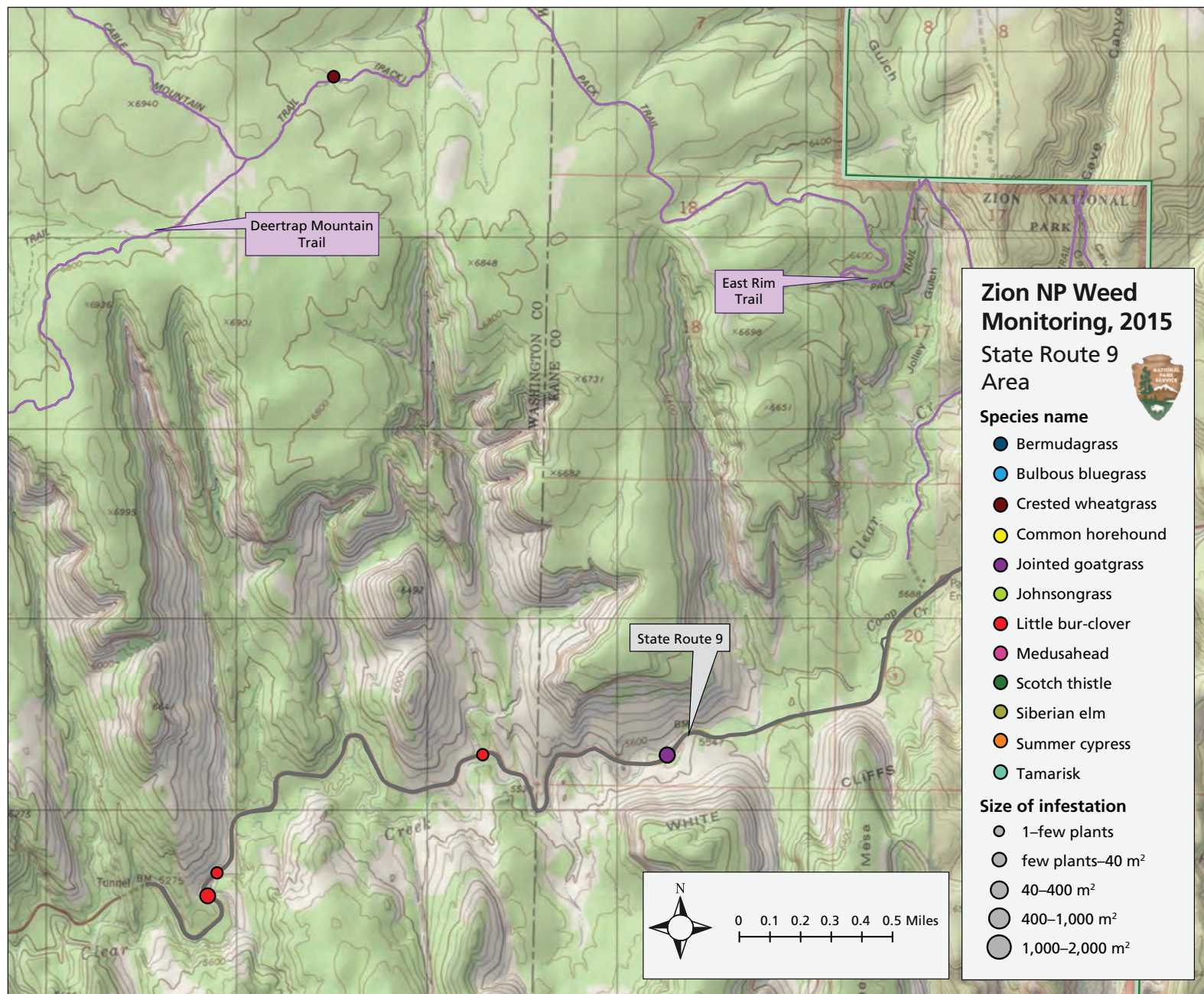


Figure 3-5. Invasive plants detected on monitoring routes in the State Route 9 area, Zion National Park, June 17-24, 2015.

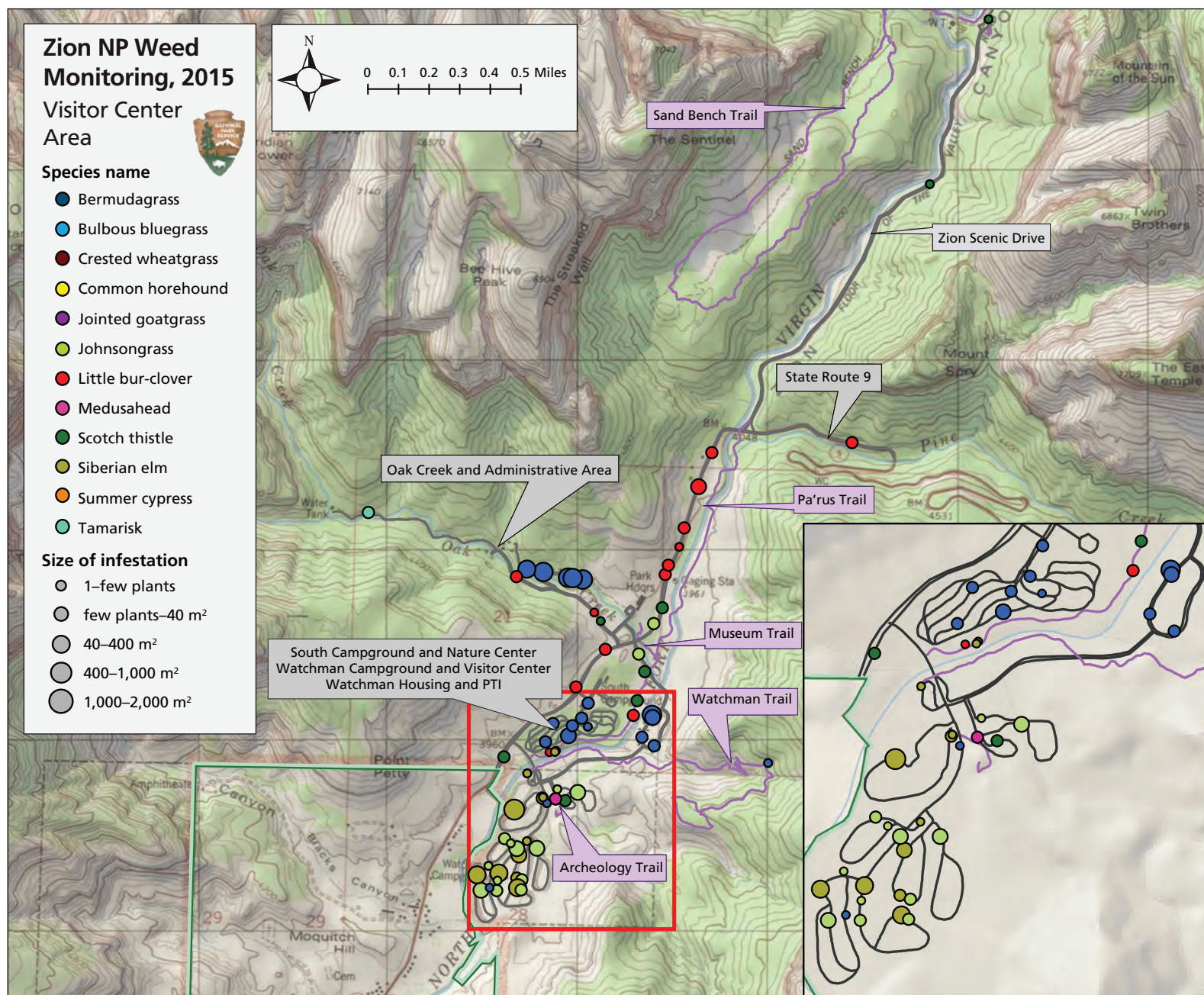


Figure 3-6. Invasive plants detected on monitoring routes in the Visitor Center area, Zion National Park, June 17–24, 2015.

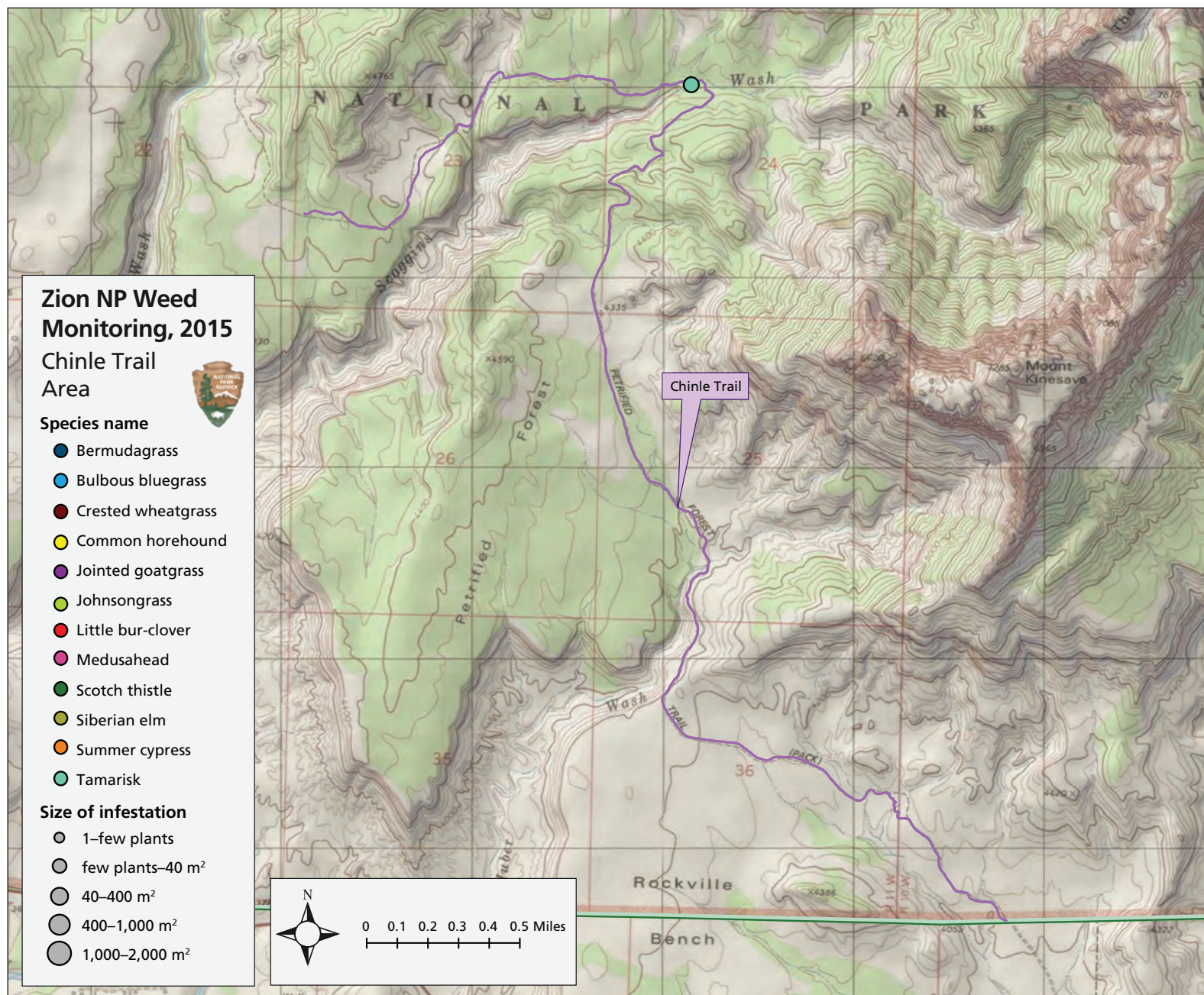


Figure 3-7. Invasive plants detected on monitoring routes in the Chinle Trail area, Zion National Park, June 17–24, 2015.

4 Discussion

4.1 Priority IEP list

The NCPN will continue to work with park staff and area IEP experts to review and update the list of priority species each year. Little bur-clover was added to the priority list in 2015. Cheatgrass and Russian thistle were added to the priority list for transects only in 2013, but these species were not mapped due to their widespread presence. 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

Scotch thistle and little bur-clover were the most widespread invasive plant species (each represented 29% of priority infestations). Scotch thistle is best controlled with manual methods, such as pulling, but careful use of herbicides can also be effective if done at the right time and growth stage. Little bur-clover is best controlled with careful use of herbicides.

Bermudagrass and Johnsongrass, the second and third-most prevalent priority IEP species, are best controlled with careful use of herbicides and manual methods, such as pulling. The decline in Johnsongrass and Siberian elm in the area of the South and Watchman campgrounds is likely the result of control efforts by Zion NP staff and contractors. While cheatgrass has declined along State Route 9 and the Main Canyon trails, these areas were not targeted for control and this decline may be due to environmental changes between the two sampling periods.

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, Watchman Housing and PTI (shuttle staging area for Parks Transportation, Inc.) area, Grotto and Wrangler trails, and Visitor Cen-

ter Trails. Patch numbers were generally higher in areas that receive more visitation. Patch densities were also generally higher along roads than along trails. Park staff report that bulbous bluegrass has not been specifically targeted for treatment but is treated if it is observed while crews control for other species.

It should also be noted that overall percent cover was very low and many monitoring routes had either few or no priority invasive plants (see Table 3-2). Efforts should be made to keep these areas IEP-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.

A more complete analysis of changes between the 2012–2013 and 2015–2016 sample periods will be conducted after the 2016 field season, when the second complete rotation of monitoring routes is completed.

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 2016, the NCPN will continue monitoring efforts in areas of the park that were not completed in 2015 (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.

5 Literature Cited

- Andersen, K. A., and S. A. Dewey. 2007. USU Wildland weed mapping methods training supplement. Master's thesis. Utah State University, Logan, Utah. 107 pp. plus appendix.
- Dewey, S. A., and K. A. Andersen. 2005. An inventory of invasive non-native plants in Capitol Reef National Park (2003–2004): Final report. Prepared for the National Park Service, Northern Colorado Plateau Network, by Utah State University, Plants, Soils, and Biometeorology. Weed Science Research Project Report No. SD0514A, 50 pp. plus appendices.
- Elzinga, C. L., D. W. Salzer, and J. W. Wiloughby. 1998. Measuring and monitoring plant populations. USDI-BLM Technical Ref. 1730-1. Bureau of Land Management, Denver, Colorado. 477 pp.
- Loope, L. L. 1992. An overview of problems with introduced plant species in national parks and reserves of the United States. Pages 3–28 in C.P. Stone, C.W. Smith, and J.T. Tunison, eds., *Alien plant invasions in native ecosystems of Hawaii: Management and research*. Cooperative National Park Resources Studies Unit, University of Hawaii, Honolulu.
- Mooney, H., and R. J. Hobbs, eds. 2000. *Invasive species in a changing world*. Washington, D.C.: Island Press. 457 pp.
- National Research Council (NRC). 2002. *Predicting invasions of nonindigenous plants and plant pests*. National Academy of Sciences, Washington, D.C.
- O'Dell, T., S. Garman, A. Evenden, M. Beer, E. Nance, D. Perry, R. DenBleyker, et al. 2005. Northern Colorado Plateau Inventory and Monitoring Network vital signs monitoring plan. National Park Service, Inventory and Monitoring Network, Moab, Utah. 174 pp. plus appendices.
- Perkins, D. 2013. Invasive exotic plant monitoring in Zion National Park: 2012 field season. Natural Resource Technical Report NPS/NCPN/NRTR—2013/749. National Park Service, Fort Collins, Colorado.
- Scott, J. M., and D. S. Wilcove. 1998. Improving the future for endangered species. *BioScience* 48(8):579–580.
- Stohlgren, T. J., D. T. Barnett, and S. E. Simonson. 2005. Beyond North American Weed Management Association standards. <http://www.nawma.org/documents/Mapping%20Standards/BEYOND%20NAWMA%20STANDARDS.pdf>.

Appendix A. Exotic Plant Patches Detected on Monitoring Routes, Zion NP, June 17–24, 2015.

Plot_ID	Species	Master_Common_Name	Pulled	Growth_Stage	Cover_Class	Size_Class	N_Coord	E_Coord
Chinle Trail	Tamarix sp.	tamarisk	0	Sapling(s)	2	3	4120216.445	318089.465
Deertrap Mountain Trail	Agropyron cristatum	crested wheatgrass	0		3	2	4125055.179	330450.087
East Rim Trail	Poa bulbosa	Bulbous bluegrass	0		1	3	4126595.842	328262.444
East Rim Trail	Poa bulbosa	Bulbous bluegrass	0		5	1	4126525.878	328295.915
East Rim Trail	Poa bulbosa	Bulbous bluegrass	0		2	3	4126524.974	328419.011
East Rim Trail	Poa bulbosa	Bulbous bluegrass	0		1	2	4126579.864	328302.365
East Rim Trail	Poa bulbosa	Bulbous bluegrass	0		1	3	4126617.237	328200.072
Grotto Trail	Onopordum acanthium	Scotch thistle	0		3	2	4124648.287	326572.901
Grotto Trail	Tamarix sp.	tamarisk	0	Sapling(s)	5	1	4124795.304	326675.291
Kolob Scenic Drive	Marrubium vulgare	Common horehound	0		5	1	4147515.967	306343.764
Kolob Scenic Drive	Marrubium vulgare	Common horehound	0		2	2	4147517.02	306309.004
Kolob Scenic Drive	Medicago minima	little bur-clover	0		2	2	4148457.655	304674.166
Kolob Scenic Drive	Onopordum acanthium	Scotch thistle	0		4	2	4147503.006	306331.175
Kolob Scenic Drive	Onopordum acanthium	Scotch thistle	0		5	1	4148438.566	304517.242
Kolob Scenic Drive	Onopordum acanthium	Scotch thistle	0		5	1	4147570.612	303204.588
Kolob Scenic Drive	Onopordum acanthium	Scotch thistle	1		5	1	4147438.251	306633.364
Kolob Scenic Drive	Onopordum acanthium	Scotch thistle	0		5	1	4147618.749	303001.891
Kolob Scenic Drive	Onopordum acanthium	Scotch thistle	0		2	2	4148023.511	303406.977
Kolob Scenic Drive	Onopordum acanthium	Scotch thistle	1		5	1	4148437.41	305302.342
Kolob Scenic Drive	Ulmus pumila	Siberian elm	0	Sapling(s)	3	2	4147485.46	306226.061
Lower Emerald Pools Trail	Medicago minima	little bur-clover	0		2	3	4124749.412	326344.526
Lower Emerald Pools Trail	Medicago minima	little bur-clover	0		2	4	4124621.28	326271.967
Lower Emerald Pools Trail	Poa bulbosa	Bulbous bluegrass	0		5	1	4125046.958	326062.49
Lower Emerald Pools Trail	Poa bulbosa	Bulbous bluegrass	0		5	1	4124862.562	326286.495
Oak Creek and Administrative	Cynodon dactylon	Bermuda grass	0		2	5	4120046.716	323963.811
Oak Creek and Administrative	Cynodon dactylon	Bermuda grass	0		2	4	4120100.682	323671.009
Oak Creek and Administrative	Cynodon dactylon	Bermuda grass	0		2	5	4120086.728	323757.504
Oak Creek and Administrative	Cynodon dactylon	Bermuda grass	0		2	5	4120055.154	323912.018
Oak Creek and Administrative	Cynodon dactylon	Bermuda grass	0		2	5	4120056.665	323887.139
Oak Creek and Administrative	Medicago minima	little bur-clover	0		1	2	4120061.751	323614.696
Oak Creek and Administrative	Medicago minima	little bur-clover	0		5	1	4119872.616	324024.635
Oak Creek and Administrative	Onopordum acanthium	Scotch thistle	0		5	1	4119828.546	324059.092
Oak Creek and Administrative	Tamarix sp.	tamarisk	0	Sapling(s)	1	2	4120398.777	322835.7
Parus Trail	Medicago minima	little bur-clover	0		1	2	4119332.015	324230.705

Appendix A. Exotic Plant Patches Detected on Monitoring Routes, Zion NP, June 17–24, 2015, cont.

Plot_ID	Species	Master_Common_Name	Pulled	Growth_Stage	Cover_Class	Size_Class	N_Coord	E_Coord
Parus Trail	Medicago minima	little bur-clover	0	Sapling(s)	5	1	4119136.765	323788.528
Parus Trail	Onopordum acanthium	Scotch thistle	0		2	2	4119409.298	324252.057
Parus Trail	Onopordum acanthium	Scotch thistle	0		2	2	4119561.341	324290.331
Parus Trail	Onopordum acanthium	Scotch thistle	0		5	1	4119144.969	323823.058
Parus Trail	Ulmus pumila	Siberian elm	0		5	1	4119139.561	323818.036
South CG and Nature Center	Cynodon dactylon	Bermuda grass	0		3	3	4119223.472	323888.911
South CG and Nature Center	Cynodon dactylon	Bermuda grass	0		3	1	4119270.784	323990.594
South CG and Nature Center	Cynodon dactylon	Bermuda grass	0		2	2	4119191.91	323768.277
South CG and Nature Center	Cynodon dactylon	Bermuda grass	0		2	2	4119316.25	323959.658
South CG and Nature Center	Cynodon dactylon	Bermuda grass	0		2	2	4119287.646	323808.081
South CG and Nature Center	Cynodon dactylon	Bermuda grass	0		3	2	4119396.713	323993.078
South CG and Nature Center	Cynodon dactylon	Bermuda grass	0		3	2	4119276.813	323909.891
State Route 9	Aegilops cylindrica	Jointed goatgrass	0		2	3	4121491.826	332201.328
State Route 9	Medicago minima	little bur-clover	0		3	2	4119481.511	323928.536
State Route 9	Medicago minima	little bur-clover	0		2	2	4120873.509	329836.165
State Route 9	Medicago minima	little bur-clover	0		3	2	4120122.059	324415.182
State Route 9	Medicago minima	little bur-clover	0		2	2	4120319.063	324498.907
State Route 9	Medicago minima	little bur-clover	0		1	3	4120536.059	324573.874
State Route 9	Medicago minima	little bur-clover	0		2	3	4120751.865	329787.261
State Route 9	Medicago minima	little bur-clover	0		3	2	4120714.953	324643.032
State Route 9	Medicago minima	little bur-clover	0		2	2	4120768.28	325381.173
State Route 9	Medicago minima	little bur-clover	0		1	2	4121493.707	331233.034
State Route 9	Medicago minima	little bur-clover	0		2	2	4120073.718	324397.896
State Route 9	Medicago minima	little bur-clover	0		5	1	4120218.365	324472.482
State Route 9	Medicago minima	little bur-clover	0		1	2	4119678.147	324082.703
State Route 9	Onopordum acanthium	Scotch thistle	0		2	2	4119897.172	324383.702
State Route 9	Onopordum acanthium	Scotch thistle	0		2	2	4119113.857	323549.979
State Route 9	Sorghum halepense	Johnson-grass	0		3	2	4119815.037	324338.223
Watchman CG and VC	Cynodon dactylon	Bermuda grass	0		4	1	4118869.789	323774.96
Watchman CG and VC	Cynodon dactylon	Bermuda grass	0		5	1	4118425.075	323474.214
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		3	2	4118410.093	323512.553
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		5	1	4118462.464	323514.985
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		3	3	4118410.42	323428.678
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		3	1	4118658.392	323585.213

Appendix A. Exotic Plant Patches Detected on Monitoring Routes, Zion NP, June 17–24, 2015, cont.

Plot_ID	Species	Master_Common_Name	Pulled	Growth_Stage	Cover_Class	Size_Class	N_Coord	E_Coord
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		5	1	4118540.032	323469.178
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		2	2	4118413.323	323639.671
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		1	2	4118682.715	323553.275
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		2	3	4118630.874	323618.264
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		2	3	4118631.19	323722.489
Watchman CG and VC	Sorghum halepense	Johnson-grass	0		3	2	4118465.951	323644.113
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Mature Tree(s)	2	4	4118424.655	323620.48
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Seedling(s)	1	5	4118835.442	323605.045
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Mature Tree(s)	5	1	4118899.396	323754.966
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Sapling(s)	5	1	4119026.474	323672.472
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Seedling(s)	2	2	4118476.213	323617.025
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Mature Tree(s)	3	2	4118895.568	323751.57
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Seedling(s)	5	1	4118670.423	323670.8
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Seedling(s)	2	3	4118595.833	323628.657
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Mature Tree(s)	3	4	4118501.808	323523.769
Watchman CG and VC	Ulmus pumila	Siberian elm	0	Mature Tree(s)	3	4	4118493.069	323407.606
Watchman Housing and PTI	Cynodon dactylon	Bermuda grass	0		1	5	4119333.257	324329.452
Watchman Housing and PTI	Cynodon dactylon	Bermuda grass	0		4	3	4119321.289	324331.474
Watchman Housing and PTI	Cynodon dactylon	Bermuda grass	0		3	2	4119172.402	324339.409
Watchman Housing and PTI	Cynodon dactylon	Bermuda grass	0		3	2	4119217.193	324275.026
Watchman Housing and PTI	Onopordum acanthium	Scotch thistle	0		3	2	4118883.033	323872.456
Watchman Housing and PTI	Sorghum halepense	Johnson-grass	0		4	1	4118942.557	323831.149
Watchman Housing and PTI	Sorghum halepense	Johnson-grass	0		2	3	4118926.556	323937.453
Watchman Housing and PTI	Sorghum halepense	Johnson-grass	0		1	2	4119655.215	324258.732
Watchman Housing and PTI	Taeniatherum caput-medusae	medusahead	0		3	2	4118892.856	323820.96
Watchman Trail	Cynodon dactylon	Bermuda grass	0		2	1	4119080.493	324940.044
Wrangler Trail	Tamarix sp.	tamarisk	0	Sapling(s)	5	1	4124313.135	326339.119
Zion Scenic Drive	Bassia scoparia	Summer-cypress	1		2	2	4126086.684	327458.116
Zion Scenic Drive	Medicago minima	little bur-clover	0		3	2	4126014.03	327279.011
Zion Scenic Drive	Medicago minima	little bur-clover	0		3	3	4126949.815	327542.771
Zion Scenic Drive	Medicago minima	little bur-clover	0		4	1	4124403.769	326361.08
Zion Scenic Drive	Onopordum acanthium	Scotch thistle	0		5	1	4123211.323	326227.695
Zion Scenic Drive	Onopordum acanthium	Scotch thistle	0		1	4	4124873.209	326635.458
Zion Scenic Drive	Onopordum acanthium	Scotch thistle	0		1	3	4124316.989	326364.248

Appendix A. Exotic Plant Patches Detected on Monitoring Routes, Zion NP, June 17–24, 2015, cont.

Plot_ID	Species	Master_Common_ Name	Pulled	Growth_Stage	Cover_Class	Size_Class	N_Coord	E_Coord
Zion Scenic Drive	Onopordum acanthium	Scotch thistle	0		5	1	4124841.906	326598.999
Zion Scenic Drive	Onopordum acanthium	Scotch thistle	0		5	1	4122996.38	326099.136
Zion Scenic Drive	Onopordum acanthium	Scotch thistle	0		1	3	4124793.094	326552.21
Zion Scenic Drive	Onopordum acanthium	Scotch thistle	0		5	1	4122128.019	325789.991
Zion Scenic Drive	Sorghum halepense	Johnson-grass	0		5	1	4125361.535	326903.194
Zion Scenic Drive	Tamarix sp.	tamarisk	0	Sapling(s)	1	4	4124258.354	326372.122

Appendix B. Exotic Plant Transect Data, Zion NP, June 17–24, 2015.

Plot_ID	Transect	Species	Master_ Common_Name	Cover_ Average	E_Coord	N_Coord
Archeology Trail	1001	Bromus tectorum	Cheatgrass	0.5	323821.369	4118814.475
Cable Mountain Trail	1006	Bromus tectorum	Cheatgrass	0.167	329159.989	4125350.726
Cable Mountain Trail	1007	Bromus tectorum	Cheatgrass	1.667	329493.862	4125030.416
Cable Mountain Trail	1008	Bromus tectorum	Cheatgrass	0.5	329866.79	4124741.323
Chinle Trail	1494	Bromus tectorum	Cheatgrass	0.167	316522.148	4119495.859
Chinle Trail	1495	Bromus tectorum	Cheatgrass	0.5	316757.882	4119895.355
Chinle Trail	1496	Bromus tectorum	Cheatgrass	0.167	317029.732	4120242.252
Chinle Trail	1497	Bromus tectorum	Cheatgrass	0.167	317477.908	4120264.149
Chinle Trail	1499	Bromus tectorum	Cheatgrass	0.333	318091.101	4120095.934
Chinle Trail	1500	Bromus tectorum	Cheatgrass	0.5	317854.978	4119793.1
Chinle Trail	1502	Bromus tectorum	Cheatgrass	0.167	317563.473	4119113.655
Chinle Trail	1504	Bromus tectorum	Cheatgrass	0.167	317842.249	4118168.333
Chinle Trail	1506	Bromus tectorum	Cheatgrass	0.167	318107.419	4117409.093
Chinle Trail	1509	Bromus tectorum	Cheatgrass	0.167	318781.24	4116608.249
Chinle Trail	1511	Bromus tectorum	Cheatgrass	0.333	319514.119	4115974.19
Deertrap Mountain Trail	1445	Bromus tectorum	Cheatgrass	0.333	327458.473	4123990.444
Deertrap Mountain Trail	1446	Bromus tectorum	Cheatgrass	1.167	327448.466	4123511.844
Deertrap Mountain Trail	1447	Bromus tectorum	Cheatgrass	0.667	327773.944	4123471.242
Deertrap Mountain Trail	1449	Bromus tectorum	Cheatgrass	3	328366.455	4123491.179
Deertrap Mountain Trail	1450	Bromus tectorum	Cheatgrass	1.833	328922.797	4123808.303
Deertrap Mountain Trail	1451	Bromus tectorum	Cheatgrass	0.167	329048.659	4124084.168
Deertrap Mountain Trail	1452	Bromus tectorum	Cheatgrass	0.5	329449.442	4124216.18
Deertrap Mountain Trail	1453	Bromus tectorum	Cheatgrass	0.5	329844.678	4124487.907
Deertrap Mountain Trail	1456	Bromus tectorum	Cheatgrass	0.333	330196.651	4124816.624
Deertrap Mountain Trail	1458	Bromus tectorum	Cheatgrass	1.833	330946.99	4125152.377
Deertrap Mountain Trail	1459	Bromus tectorum	Cheatgrass	0.167	330958.7	4125612.508
East Mesa Trail	1341	Bromus tectorum	Cheatgrass	0.167	331292.058	4129460.085
East Mesa Trail	1343	Bromus tectorum	Cheatgrass	0.167	330530.082	4129317.574
East Mesa Trail	1344	Bromus tectorum	Cheatgrass	0.333	330136.852	4129489.056
East Mesa Trail	1350	Bromus tectorum	Cheatgrass	0.333	328347.939	4127900.385
East Mesa Trail	1353	Bromus tectorum	Cheatgrass	0.167	328989.311	4127257.003
East Rim Trail	1355	Bromus tectorum	Cheatgrass	0.5	333474.739	4122716.964
East Rim Trail	1357	Bromus tectorum	Cheatgrass	2.833	333839.473	4123495.889
East Rim Trail	1359	Bromus tectorum	Cheatgrass	0.167	334448.458	4124006.548
East Rim Trail	1361	Bromus tectorum	Cheatgrass	0.167	334300.628	4124025.414
East Rim Trail	1362	Bromus tectorum	Cheatgrass	0.167	333902.406	4123785.357
East Rim Trail	1365	Bromus tectorum	Cheatgrass	0.333	333353.44	4124000.84
East Rim Trail	1371	Bromus tectorum	Cheatgrass	0.5	331845.004	4124913.466
East Rim Trail	1375	Bromus tectorum	Cheatgrass	1.833	330853.463	4126383.343
East Rim Trail	1385	Bromus tectorum	Cheatgrass	0.333	328507.164	4126584.495
East Rim Trail	1386	Bromus tectorum	Cheatgrass	0.167	328421.344	4126547.071
East Rim Trail	1387	Bromus tectorum	Cheatgrass	0.333	328214.964	4126508.822
East Rim Trail	1388	Bromus tectorum	Cheatgrass	0.167	328239.445	4126622.561
Grotto Trail	1454	Poa bulbosa	Bulbous bluegrass	0.333	327157.874	4125373.883
Kolob Scenic Drive	1177	Bromus tectorum	Cheatgrass	0.167	305463.809	4145611.731
Kolob Scenic Drive	1179	Bromus tectorum	Cheatgrass	0.167	305957.814	4146416.691
Kolob Scenic Drive	1180	Bromus tectorum	Cheatgrass	0.167	306034.755	4146901.62

Appendix B. Exotic Plant Transect Data, Zion NP, June 17–24, 2015, cont.

Plot_ID	Transect	Species	Master_ Common_Name	Cover_ Average	E_Coord	N_Coord
Kolob Scenic Drive	1181	Salsola tragus	Russian-thistle	0.167	306231.912	4147336.635
Kolob Scenic Drive	1182	Bromus tectorum	Cheatgrass	0.167	306700.468	4147449.976
Kolob Scenic Drive	1184	Bromus tectorum	Cheatgrass	0.333	306082.778	4147571.24
Kolob Scenic Drive	1185	Bromus tectorum	Cheatgrass	0.333	305781.466	4147963.254
Kolob Scenic Drive	1186	Bromus tectorum	Cheatgrass	0.167	305717.944	4148401.834
Kolob Scenic Drive	1187	Bromus tectorum	Cheatgrass	1.833	305264.935	4148432.955
Kolob Scenic Drive	1188	Bromus tectorum	Cheatgrass	1	304767.223	4148445.981
Kolob Scenic Drive	1189	Bromus tectorum	Cheatgrass	0.5	304308.904	4148326.849
Kolob Scenic Drive	1190	Bromus tectorum	Cheatgrass	0.333	303861.814	4148430.762
Kolob Scenic Drive	1191	Bromus tectorum	Cheatgrass	0.167	303504.219	4148322.66
Kolob Scenic Drive	1193	Bromus tectorum	Cheatgrass	0.167	303081.159	4147598.031
Kolob Scenic Drive	1194	Salsola tragus	Russian-thistle	0.167	302962.938	4147619.796
Kolob Scenic Drive	1195	Bromus tectorum	Cheatgrass	0.167	303323.645	4147654.118
Kolob Scenic Drive	1196	Bromus tectorum	Cheatgrass	4.167	303447.567	4148131.687
Kolob Scenic Drive	1197	Bromus tectorum	Cheatgrass	0.167	303681.418	4148478.61
Kolob Scenic Drive	1198	Bromus tectorum	Cheatgrass	0.333	304115.404	4148313.279
Kolob Scenic Drive	1199	Bromus tectorum	Cheatgrass	0.167	304584.451	4148468.635
Kolob Scenic Drive	1200	Bromus tectorum	Cheatgrass	0.167	305082.86	4148428.613
Kolob Scenic Drive	1201	Bromus tectorum	Cheatgrass	0.333	305558.408	4148366.824
Kolob Scenic Drive	1203	Bromus tectorum	Cheatgrass	0.167	305973.671	4147672.459
Kolob Scenic Drive	1204	Bromus tectorum	Cheatgrass	0.167	306384.306	4147541.207
Kolob Scenic Drive	1205	Bromus tectorum	Cheatgrass	0.5	306779.813	4147526.604
Kolob Scenic Drive	1207	Bromus tectorum	Cheatgrass	0.167	306065.959	4147041.592
Kolob Scenic Drive	1208	Bromus tectorum	Cheatgrass	0.5	305932.98	4146574.95
Kolob Scenic Drive	1210	Bromus tectorum	Cheatgrass	0.167	305561.752	4145687.364
Middle Taylor Creek Trail	1092	Bromus tectorum	Cheatgrass	0.5	305518.5	4148476.54
Museum Trail	1093	Bromus tectorum	Cheatgrass	2.5	324268.264	4119772.248
Oak Creek and Administrative	1250	Bromus tectorum	Cheatgrass	0.333	322824.862	4120395.024
Oak Creek and Administrative	1253	Bromus tectorum	Cheatgrass	0.5	324037.669	4119869.239
Oak Creek and Administrative	1254	Bromus tectorum	Cheatgrass	0.167	323597.945	4120073.348
Oak Creek and Administrative	1255	Bromus tectorum	Cheatgrass	2	324031.177	4119864.972
Oak Creek and Administrative	1256	Bromus tectorum	Cheatgrass	0.5	323700.71	4120085.574
Parus Trail	1099	Bromus tectorum	Cheatgrass	0.5	323860.748	4119185.364
Parus Trail	1100	Bromus tectorum	Cheatgrass	0.333	324233.464	4119376.56
Parus Trail	1101	Bromus tectorum	Cheatgrass	0.5	324422.721	4119807.115
Parus Trail	1102	Bromus tectorum	Cheatgrass	0.833	324597.303	4120233.203
Parus Trail	1102	Salsola tragus	Russian-thistle	33.667	324597.303	4120233.203
Parus Trail	1103	Bromus tectorum	Cheatgrass	10	324762.268	4120634.138
Riverside Walk	1104	Bromus tectorum	Cheatgrass	0.167	327323.861	4129389.029
Sand Bench Trail	1391	Bromus tectorum	Cheatgrass	0.333	325572.515	4122772.077
Sand Bench Trail	1393	Bromus tectorum	Cheatgrass	0.5	325145.764	4122042.742
Sand Bench Trail	1396	Bromus tectorum	Cheatgrass	0.333	324575.223	4121827.977
Sand Bench Trail	1397	Bromus tectorum	Cheatgrass	0.5	324939.337	4122137.432
Sand Bench Trail	1398	Bromus tectorum	Cheatgrass	2	325207.978	4122494.8
Sand Bench Trail	1399	Bromus tectorum	Cheatgrass	0.333	325507.069	4122822.668
Sand Bench Trail	1400	Bromus tectorum	Cheatgrass	0.333	325590.228	4123054.818
Sand Bench Trail	1401	Bromus tectorum	Cheatgrass	1.5	325805.588	4123173.282
Sand Bench Trail	1402	Bromus tectorum	Cheatgrass	1	326088.206	4123453.846

Appendix B. Exotic Plant Transect Data, Zion NP, June 17–24, 2015, cont.

Plot_ID	Transect	Species	Master_ Common_Name	Cover_ Average	E_Coord	N_Coord
Sand Bench Trail	1403	Bromus tectorum	Cheatgrass	11.667	326269.996	4123876.877
Sand Bench Trail	1404	Bromus tectorum	Cheatgrass	0.167	326264.695	4124348.564
Sand Bench Trail	1405	Bromus tectorum	Cheatgrass	10.167	325732.456	4123058.811
State Route 9	1262	Bromus tectorum	Cheatgrass	0.333	324584.141	4120601.991
State Route 9	1263	Bromus tectorum	Cheatgrass	7.167	324424.696	4120129.305
State Route 9	1263	Salsola tragus	Russian-thistle	0.167	324424.696	4120129.305
State Route 9	1264	Bromus tectorum	Cheatgrass	0.167	324210.806	4119720.339
State Route 9	1264	Salsola tragus	Russian-thistle	0.333	324210.806	4119720.339
State Route 9	1265	Bromus tectorum	Cheatgrass	0.667	323857.656	4119395.228
State Route 9	1266	Bromus tectorum	Cheatgrass	0.667	323509.086	4119066.392
State Route 9	1266	Salsola tragus	Russian-thistle	0.167	323509.086	4119066.392
State Route 9	1267	Bromus tectorum	Cheatgrass	5	325430.009	4120747.762
State Route 9	1267	Salsola tragus	Russian-thistle	0.167	325430.009	4120747.762
State Route 9	1268	Bromus tectorum	Cheatgrass	0.5	324953.573	4120817.067
State Route 9	1269	Bromus tectorum	Cheatgrass	5	324597.618	4120606.132
State Route 9	1270	Bromus tectorum	Cheatgrass	1.167	324432.682	4120132.834
State Route 9	1271	Bromus tectorum	Cheatgrass	3.667	324220.977	4119712.988
State Route 9	1271	Salsola tragus	Russian-thistle	0.333	324220.977	4119712.988
State Route 9	1272	Bromus tectorum	Cheatgrass	0.833	323873.079	4119391.467
State Route 9	1272	Salsola tragus	Russian-thistle	2.833	323873.079	4119391.467
State Route 9	1273	Bromus tectorum	Cheatgrass	0.667	323524.142	4119062.415
State Route 9	1273	Salsola tragus	Russian-thistle	0.333	323524.142	4119062.415
State Route 9	1460	Bromus tectorum	Cheatgrass	3	334508.858	4122590.133
State Route 9	1461	Bromus tectorum	Cheatgrass	0.667	334019.211	4122494.128
State Route 9	1462	Bromus tectorum	Cheatgrass	2	333565.302	4122338.068
State Route 9	1463	Bromus tectorum	Cheatgrass	0.333	333328.704	4121927.514
State Route 9	1464	Bromus tectorum	Cheatgrass	0.667	332949.409	4121710.337
State Route 9	1465	Bromus tectorum	Cheatgrass	0.333	332467.566	4121582.176
State Route 9	1466	Bromus tectorum	Cheatgrass	0.667	332038.104	4121437.466
State Route 9	1467	Bromus tectorum	Cheatgrass	0.333	331594.339	4121443.927
State Route 9	1472	Bromus tectorum	Cheatgrass	0.333	329996.485	4121189.108
State Route 9	1473	Bromus tectorum	Cheatgrass	0.667	329769.584	4120784.541
State Route 9	1474	Bromus tectorum	Cheatgrass	0.667	329641.438	4120598.29
State Route 9	1475	Bromus tectorum	Cheatgrass	2.833	334504.569	4122604.317
State Route 9	1476	Bromus tectorum	Cheatgrass	0.667	334017.655	4122503.978
State Route 9	1477	Bromus tectorum	Cheatgrass	0.333	333564.119	4122353.867
State Route 9	1478	Bromus tectorum	Cheatgrass	0.333	333325.873	4121960.078
State Route 9	1479	Bromus tectorum	Cheatgrass	0.333	332964.293	4121720.519
State Route 9	1480	Bromus tectorum	Cheatgrass	0.5	332488.757	4121593.32
State Route 9	1481	Bromus tectorum	Cheatgrass	1	332048.176	4121452.888
State Route 9	1482	Bromus tectorum	Cheatgrass	0.333	331595.952	4121472.294
State Route 9	1484	Bromus tectorum	Cheatgrass	0.167	331058.934	4121347.187
State Route 9	1485	Bromus tectorum	Cheatgrass	0.167	330646.55	4121462.621
State Route 9	1486	Bromus tectorum	Cheatgrass	0.667	330331.127	4121392.391
State Route 9	1487	Bromus tectorum	Cheatgrass	0.167	329975.964	4121188.576
State Route 9	1488	Bromus tectorum	Cheatgrass	0.167	329761.5	4120792.727
State Route 9	1489	Bromus tectorum	Cheatgrass	0.167	329628.555	4120659.61
Stave Spring	1390	Bromus tectorum	Cheatgrass	0.167	330937.442	4126194.032

Appendix B. Exotic Plant Transect Data, Zion NP, June 17–24, 2015, cont.

Plot_ID	Transect	Species	Master_ Common_Name	Cover_ Average	E_Coord	N_Coord
Timber Creek Overlook Trail	1321	Bromus tectorum	Cheatgrass	0.167	304998.707	4144823.087
Upper Emerald Pools Trail	1108	Bromus tectorum	Cheatgrass	0.167	325821.255	4125290.982
Watchman Housing and PTI	1258	Bromus tectorum	Cheatgrass	2	323918.185	4119074.999
Watchman Housing and PTI	1258	Salsola tragus	Russian-thistle	1.167	323918.185	4119074.999
Watchman Housing and PTI	1259	Salsola tragus	Russian-thistle	0.333	323844.72	4119033.677
Watchman Trail	1407	Bromus tectorum	Cheatgrass	0.167	324645.41	4118850.534
Watchman Trail	1408	Cynodon dactylon	Bermuda grass	0.667	324920.235	4119061.768
Watchman Trail	1409	Bromus tectorum	Cheatgrass	0.333	324741.067	4119078.89
Watchman Trail	1410	Bromus tectorum	Cheatgrass	5.333	324290.105	4119097.839
Watchman Trail	1411	Bromus tectorum	Cheatgrass	0.667	323865.89	4119116.663
Watchman Trail	1411	Salsola tragus	Russian-thistle	1.5	323865.89	4119116.663
Weeping Rock	1110	Bromus tectorum	Cheatgrass	0.167	328220.004	4126667.232
West Rim Trail	1312	Bromus tectorum	Cheatgrass	0.167	326754.913	4128144.744
West Rim Trail	1319	Bromus tectorum	Cheatgrass	0.167	327045.708	4126027.211
West Rim Trail	1320	Bromus tectorum	Cheatgrass	1	327007.795	4125557.046
Wrangler Trail	1130	Bromus tectorum	Cheatgrass	0.167	326091.799	4123070.211
Wrangler Trail	1131	Bromus tectorum	Cheatgrass	0.5	326313.199	4123479.405
Wrangler Trail	1133	Bromus tectorum	Cheatgrass	0.5	326347.064	4124445.723
Zion Scenic Drive	1134	Bromus tectorum	Cheatgrass	0.167	324908.354	4121015.614
Zion Scenic Drive	1136	Bromus tectorum	Cheatgrass	2	325457.721	4121769.894
Zion Scenic Drive	1137	Bromus tectorum	Cheatgrass	0.167	325782.485	4122117.074
Zion Scenic Drive	1138	Bromus tectorum	Cheatgrass	0.167	325917.864	4122564.933
Zion Scenic Drive	1139	Bromus tectorum	Cheatgrass	0.167	326104.264	4123008.548
Zion Scenic Drive	1140	Bromus tectorum	Cheatgrass	30	326354.525	4123438.073
Zion Scenic Drive	1140	Medicago minima	little bur-clover	0.667	326354.525	4123438.073
Zion Scenic Drive	1141	Bromus tectorum	Cheatgrass	1.167	326433.107	4123915.76
Zion Scenic Drive	1142	Bromus tectorum	Cheatgrass	1.333	326367.249	4124396.213
Zion Scenic Drive	1142	Medicago minima	little bur-clover	0.667	326367.249	4124396.213
Zion Scenic Drive	1143	Bromus tectorum	Cheatgrass	2.333	326570.563	4124797.348
Zion Scenic Drive	1144	Bromus tectorum	Cheatgrass	0.167	326798.888	4125235.742
Zion Scenic Drive	1146	Bromus tectorum	Cheatgrass	0.333	327279.221	4125979.369
Zion Scenic Drive	1147	Bromus tectorum	Cheatgrass	5.333	327597.884	4126301.373
Zion Scenic Drive	1148	Bromus tectorum	Cheatgrass	3.5	327989.725	4126584.605
Zion Scenic Drive	1150	Salsola tragus	Russian-thistle	0.167	327438.591	4126941.503
Zion Scenic Drive	1151	Bromus tectorum	Cheatgrass	0.167	327520.296	4127404.209
Zion Scenic Drive	1156	Bromus tectorum	Cheatgrass	0.333	325167.597	4121356.188
Zion Scenic Drive	1157	Bromus tectorum	Cheatgrass	0.167	325447.584	4121775.508
Zion Scenic Drive	1158	Bromus tectorum	Cheatgrass	0.833	325760.158	4122127.83
Zion Scenic Drive	1159	Bromus tectorum	Cheatgrass	0.5	325900.234	4122563.521
Zion Scenic Drive	1160	Bromus tectorum	Cheatgrass	0.667	326081.632	4123002.917
Zion Scenic Drive	1161	Bromus tectorum	Cheatgrass	0.833	326338.833	4123430.911
Zion Scenic Drive	1162	Bromus tectorum	Cheatgrass	0.5	326417.475	4123905.78
Zion Scenic Drive	1163	Bromus tectorum	Cheatgrass	0.5	326363.311	4124402.28
Zion Scenic Drive	1163	Medicago minima	little bur-clover	0.167	326363.311	4124402.28
Zion Scenic Drive	1164	Bromus tectorum	Cheatgrass	0.333	326570.695	4124801.188
Zion Scenic Drive	1165	Bromus tectorum	Cheatgrass	0.333	326792.824	4125242.06
Zion Scenic Drive	1167	Bromus tectorum	Cheatgrass	10.167	327270.867	4125990.766
Zion Scenic Drive	1168	Bromus tectorum	Cheatgrass	22.667	327586.186	4126321.389

Appendix B. Exotic Plant Transect Data, Zion NP, June 17–24, 2015, cont.

Plot_ID	Transect	Species	Master_ Common_Name	Cover_ Average	E_Coord	N_Coord
Zion Scenic Drive	1169	Bromus tectorum	Cheatgrass	0.167	327985.337	4126591.527
Zion Scenic Drive	1170	Bromus tectorum	Cheatgrass	0.167	327869.998	4126980.43
Zion Scenic Drive	1171	Bromus tectorum	Cheatgrass	0.333	327426.029	4126898.539
Zion Scenic Drive	1172	Bromus tectorum	Cheatgrass	0.167	327471.721	4127370.191

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

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National Park Service
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