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Invasive Exotic Plant Monitoring in Black Canyon of the Gunnison National Park and Curecanti National Recreation Area

Field Seasons 2010–2012

Natural Resource Technical Report NPS/NCPN/NRTR—2013/750



ON THE COVER

Musk thistle (*Carduus nutans*). 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. This report documents and maps invasive plant infestations detected at Black Canyon of the Gunnison National Park (BLCA) and Curecanti National Recreation Area (CURE) during 2012. It also summarizes all work completed at the parks from 2010 to 2012 (representing the first full rotation of desired monitoring routes) and presents a rotational panel for future monitoring.

From 2010 to 2012, over 275 km were monitored at BLCA and CURE. Thirty-two IEP species were detected on monitoring routes and transects. Of these, 24 were priority species, accounting for 2,936 separate infestations. Canada thistle (*Breea arvensis*), common mullein (*Verbascum thapsus*), musk thistle (*Carduus nutans*), reed canarygrass (*Phalaris arundinacea*), Russian thistle (*Salsola australis*), and kochia (*Bassia sieversiana*) were the most commonly detected priority IEPs. The Gunnison River, shoreline of Blue Mesa Reservoir, and Red Rock Canyon had the highest percent cover of invasive species, with 7.58%, 4.06%, and 2.33%, respectively, as determined by quadrat data. At the Gunnison River and Red Rock Canyon, this percent cover was dominated by reed canarygrass, with cover of 7.58% and 1.67%, respectively. Compared to earlier surveys conducted from 2003 to 2004 at BLCA, the number of infestations declined at the Gunnison River and Red Rock Canyon, stayed about the same along trails as well as the south and north rim roads, and increased along the East Portal Road. Network staff will return to BLCA and CURE in 2014 to begin the second rotation of monitoring.

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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 in detail and provides summary information for the 2010–2011 field seasons at Black Canyon of the Gunnison National Park (BLCA) and Curecanti National Recreation Area (CURE). The 2010–2012 field seasons represent the first completion of the desired monitoring routes at BLCA and CURE. Detailed information on the 2010 and 2011 field seasons is presented in previous reports (Edvarchuk et al. 2012; Perkins 2012).

2 Methods

Field work followed the invasive exotic plant monitoring protocol developed by the NCPN (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).

The first step was to have BLCA, CURE, and NCPN staff review and update the list of priority invasive plants for the parks (see below). Next, we established a series of co-located monitoring routes and quadrats along all roads, major drainages, and trails in the parks. The quadrats, which are sampled in a quantitative manner, are used to make inference to the percent cover of priority IEPs located along the park's invasive pathways (i.e., the monitoring routes) and allow us to estimate trends in selected IEP percent cover over time. The monitoring routes, which are not quantitatively sampled, are used to increase the spatial coverage of mapping performed, with the goal of maximizing our opportunities for detecting IEPs in the park.

2.1 Developing a park priority invasive exotic plant list

NCPN, BLCA, and CURE staff review the list of priority IEPs after each field season (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. Our priority IEP list includes existing IEPs and potential IEPs of high management concern. Because these methods were designed to be rapid, field crews were trained to develop a focused search image on the priority plants, instead of looking for every possible invasive plant species. The likelihood of eradicating these priority species or containing them within a park is generally high.

Thirty-two IEP species were identified as priorities for BLCA/CURE for at least one year from 2010 to 2012 (see Table 2-1). We also recorded cheatgrass (*Anisantha tectorum*) in monitoring quadrats.

2.2 Monitoring routes

2.2.1 Minimum detection target size

The minimum detection target size (MDTS) represented the patch size that was 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

Table 2-1. Priority invasive plant list, Black Canyon of the Gunnison NP and Curecanti NRA, 2010–2012.

Scientific name	Common name
Acosta diffusa	diffuse knapweed
Acosta maculosa	spotted knapweed
Acroptilon repens	Russian knapweed
Arctium minus	common burdock
Artemisia absinthium	absinth wormwood
Bassia sieversiana	kochia
Breea arvensis	Canada thistle
Cardaria draba	hoary cress
Cardaria latifolia	perennial pepperweed
Carduus nutans	musk thistle
Cirsium vulgare	bull thistle
Clematis orientalis[a]	Chinese clematis
Convolvulus arvensis[a]	field bindweed
Cynoglossum officinale	houndstongue
Elaeagnus angustifolia	Russian olive
Hesperis matronalis	Dame's rocket
Hyoscyamus niger	black henbane
Iva xanthifolia	marsh elder
Leucanthemum vulgare	ox-eye daisy
Linaria genistifolia	Dalmatian toadflax
Linaria vulgaris	yellow toadflax
Matricaria perforata	scentless chamomile
Onopordum acanthium	Scotch thistle
Phalaris arundinacea	reed canarygrass
Potentilla recta[b]	sulfur cinquefoil
Rubus armeniacus[b]	Himalayan blackberry
Rumex crispus[a]	curly dock
Salsola australis	Russian thistle
Tamarix ramosissima	tamarisk
Tithymalus esula	leafy spurge
Ulmus pumila	Siberian elm
Verbascum thapsus	common mullein

[a]2010 only

[b]2011, 2012 only

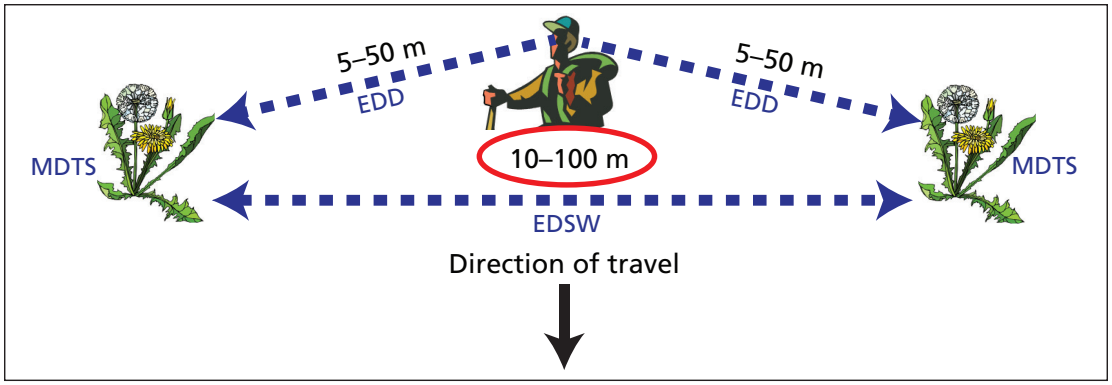


Figure 2-1. The maximum effective detection distance (EDD) at BLCA/CURE ranged from 5 to 50 meters, making the effective detection swath width (EDSW) 10–100 meters.

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 m^2 (0.01 acres or approximately 20 × 20 ft) for all IEPs. Use of the MDTS was necessary because field technicians were not expected to find every single plant of every priority weed species during route surveys. Although searching for single mature plants of some species, such as Russian olive (*Elaeagnus angustifolia*) and tamarisk (*Tamarix ramosissima*), is possible due to their large size, single plants of other species, such as field bindweed (*Convolvulus arvensis*), are nearly impossible to detect in most field conditions.

2.2.2 Effective detection distance

The effective detection distance (EDD) was the maximum distance from which a searcher could consistently detect (i.e., see and recognize) the MDTS of the least-visible priority species with at least 90% detection efficiency (Figure 2-1). Crew members calibrated themselves by walking away from a targeted patch size of the least-visible species and determining the maximum distance from which they could consistently see and recognize the patch with complete confidence. The distance was measured either by pacing or using a laser rangefinder. The EDD for BLCA/CURE was between 5 and 50 m in 2012, depending on vegetation.

2.2.3 Effective detection swath width

Effective detection swath width (EDSW) was 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 priority 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 10 to 100 m at BLCA/CURE in 2012.

2.2.4 Patch separation resolution

We defined patch separation resolution (PSR) as the minimum distance between plants that must be considered separate patches or infestations. Individuals or clusters of a priority species separated by the PSR distance or more were recorded as separate infestations. We considered plants separated by less than the PSR to be a single patch or infestation. The PSR was 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 was continuous for more than 50 m, then cover estimates were 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 the user's route. The GPS unit was set to automatically generate these positions at a distance equal to the EDSW. Each time a surveyor walked the equivalent of one EDSW, the GPS unit created a point.

2.2.6 Data collection methods

For roads, we walked five meters out from one side of the road and then returned to the starting point by walking back five meters from the road on the other side. In some cases, due to topography and property boundaries, it was not possible to walk five meters from the road. For single-track trails and reservoir shorelines, we walked the center of the trail or drainage in only one direction (Figures 2-2, 2-3, 2-4; figures begin on page 7).

While walking, we searched for selected 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 10–100 m (the length of one EDSW) and visually scanned the area in all directions. As monitoring routes were traversed, locations of all priority species were documented using global positioning system (GPS) units with at least five-meter accuracy.

Only species that were designated as priority were consistently recorded on monitoring routes. Survey crew members were given the latitude 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 identification number. Invasions more than 50 m (55 yards) apart were considered separate invasions and recorded with a separate point.

Infestation size class was estimated as follows:

1. 1–a few plants (used for isolated single plants or very small patches (2 × 2 m)
2. few plants–40 m^2 (48 yd^2)
3. 40–400 m^2 (48–478 yd^2)
4. 400–1,000 m^2 (0.1–0.25 acre)
5. 1,000–2,000 m^2 (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 (i.e., sapling, pole, mature), evidence of prior treatment, and evidence of disturbances (e.g., recent fire, flood, small mammal disturbance).

2.3 Monitoring transects

Our methods for sampling monitoring transects and associated quadrats were based on Stohlgren and others (2005). We established transects with three vegetation quadrats every 500 m along monitoring routes (Figures 2-5, 2-6). If no invasives were detected for four consecutive transects (i.e., 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 back 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 that was being walked and on alternating sides for riparian areas, small roads, or trails. If there was not enough space between the route and a topographic feature or property boundary, then the three quadrats were evenly spaced between the route and the boundary. A 1-m^2 sampling frame was used to sample cover of vegetation and soil surface features by placing it on the alternating sides of the transect line as

the technician walked from the monitoring route. In some cases, the sampling frame was leveled 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. 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 number of infestations per hectare 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.

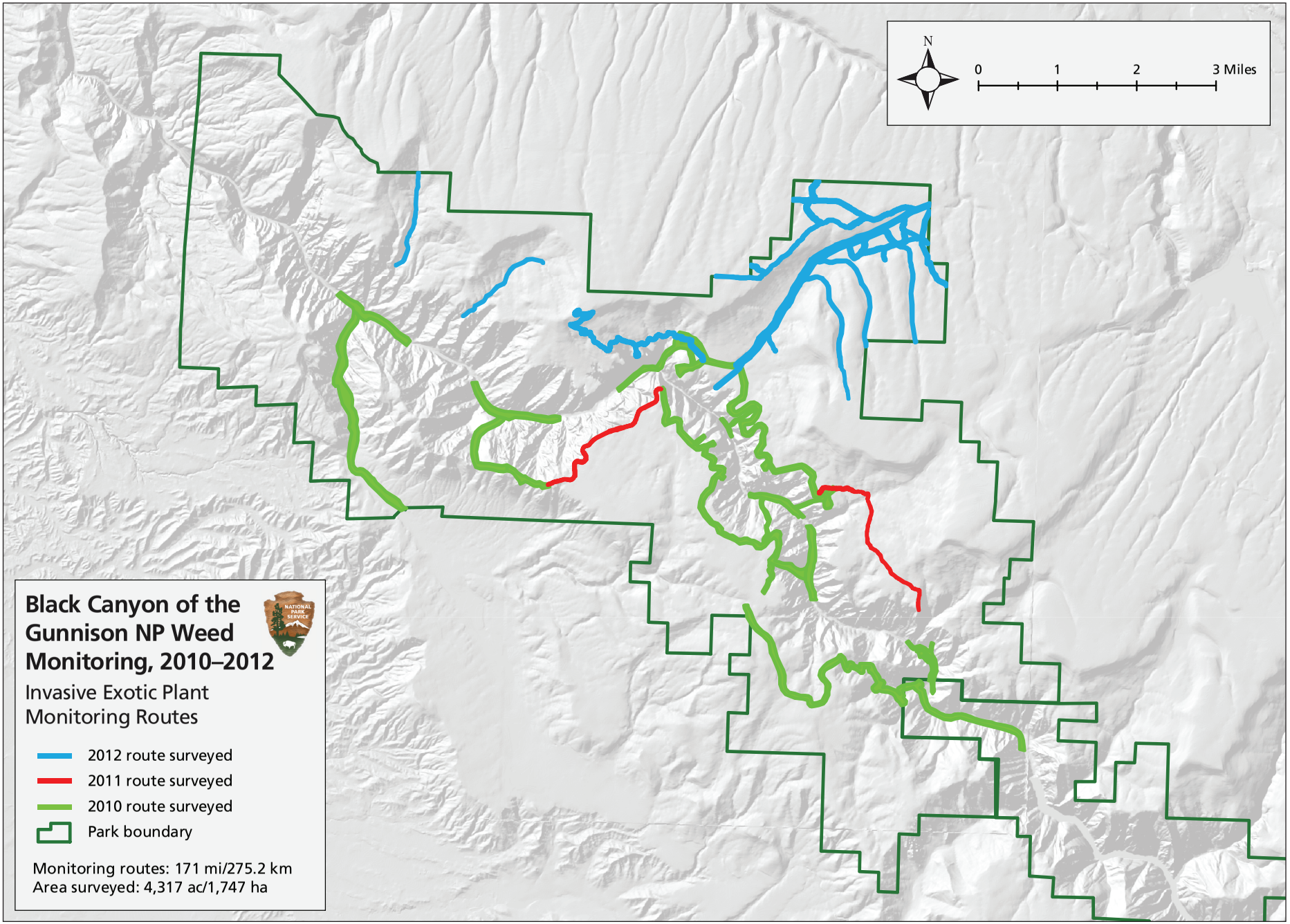


Figure 2-2. Overview of invasive plant monitoring routes and extra areas surveyed, Black Canyon of the Gunnison NP, 2010–2012.

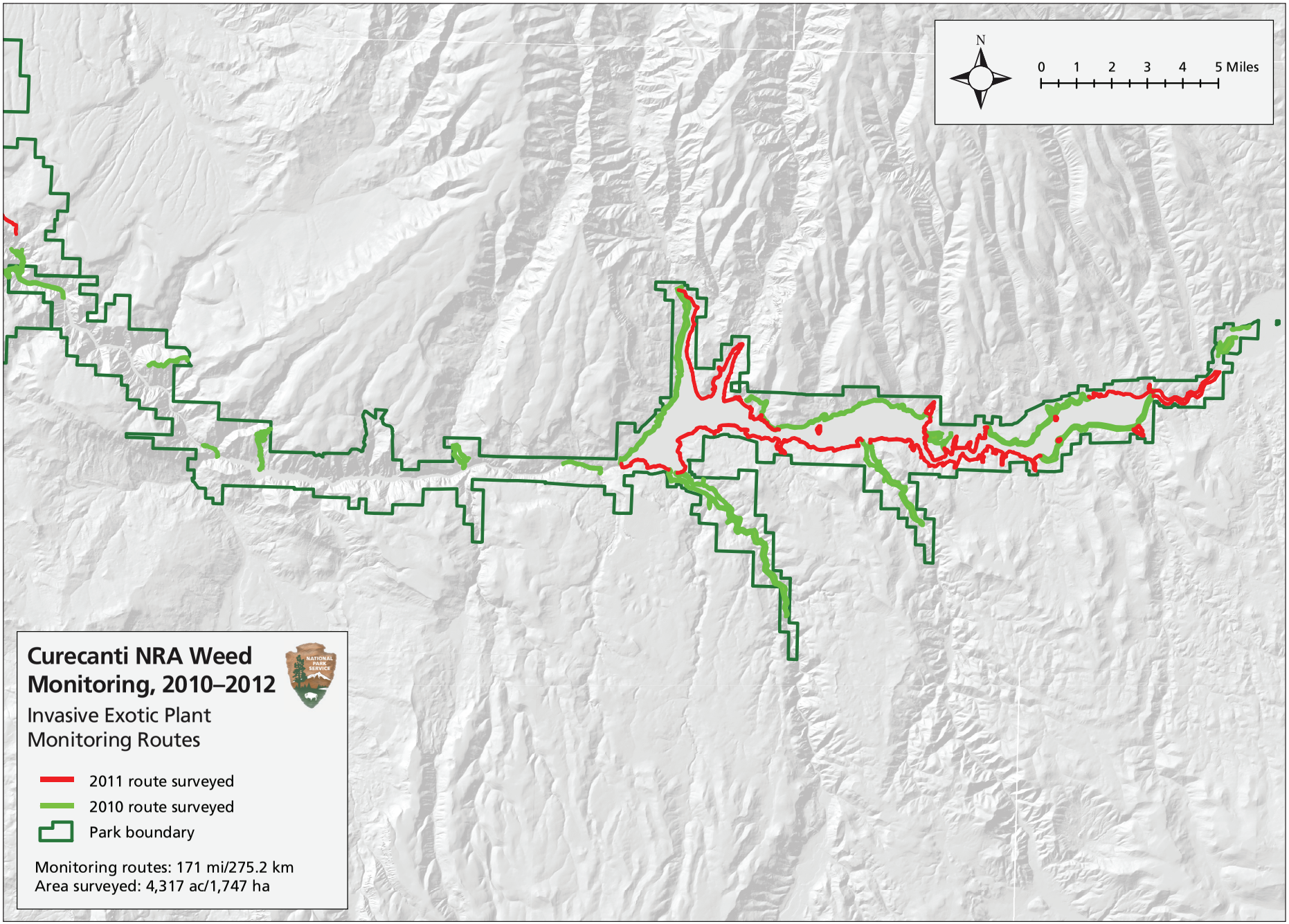


Figure 2-3. Overview of invasive plant monitoring routes and extra areas surveyed, Curecanti NRA, 2010–2012.

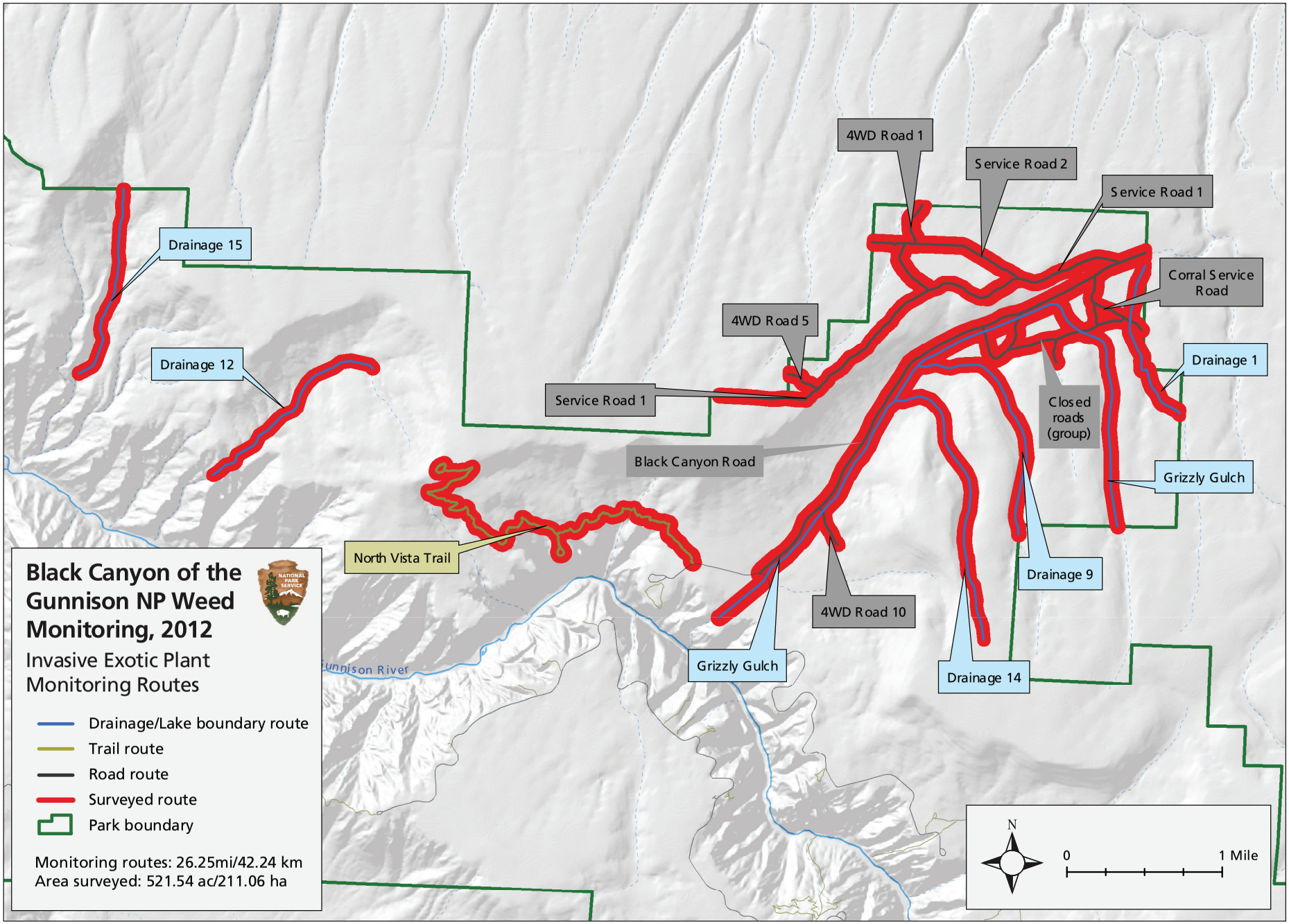


Figure 2-4. Monitoring routes surveyed, Black Canyon of the Gunnison NP, August 1–3, 2012.

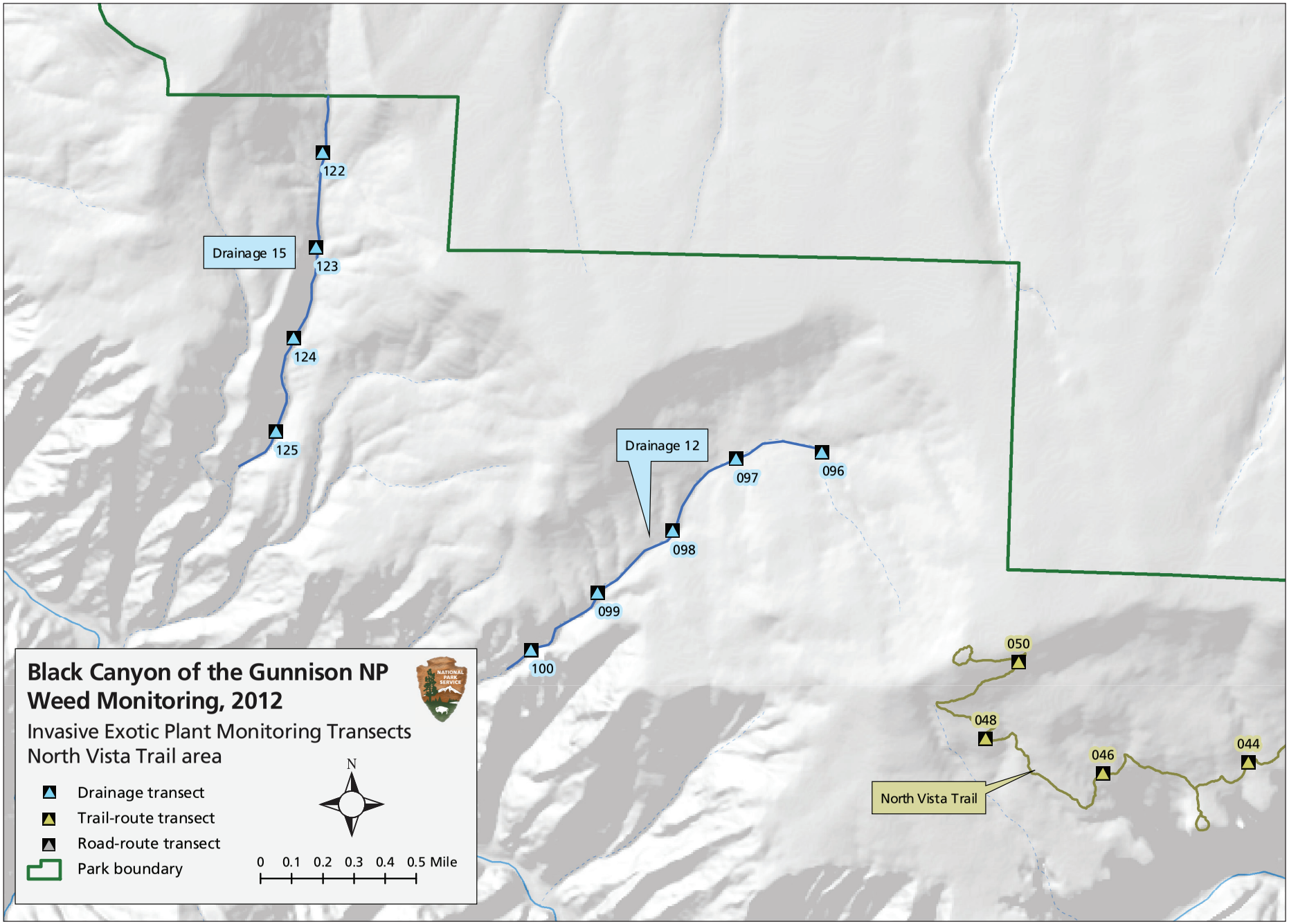


Figure 2-5. Monitoring quadrats established in the North Vista Trail area, Black Canyon of the Gunnison NP, August 1–3, 2012.

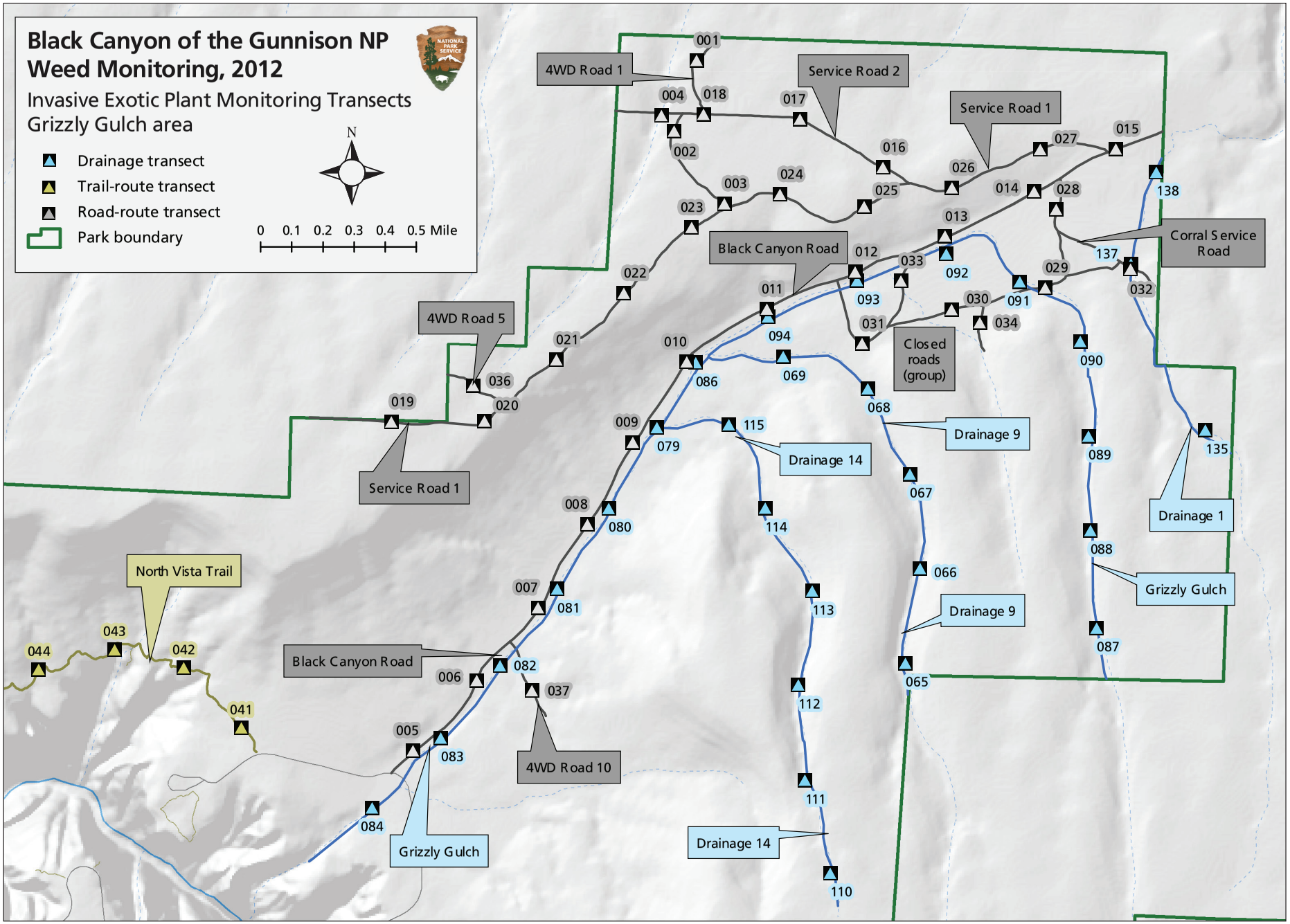


Figure 2-6. Monitoring quadrats established in the Grizzly Gulch area, Black Canyon of the Gunnison NP, August 1–3, 2012.

3 Results

3.1 Priority invasive exotic plant list

Thirty-three unique IEP species were recorded on monitoring routes and quadrats from 2010 to 2012, 24 of which were priority species (Table 3-1; tables begin on page 15). Twenty-six IEP species were recorded on monitoring routes and 18 in monitoring quadrats. Of those recorded species, 22 and 10 were priority species, respectively. We covered 1,747 hectares (4,317 acres) along 275.2 kilometers (171 miles) of monitoring routes from 2010 to 2012.

3.2 Monitoring routes

3.2.1 2012 results

A total of 199 infestations, 194 of which were priority species, were detected along monitoring routes in 2012 (Tables 3-2 and 3-3, Figures 3-1, 3-2, 3-3, 3-4, 3-5, Electronic Appendix A; figures begin on page 20). Musk thistle, Russian thistle, and spotted knapweed were the most commonly detected priority IEPs (Table 3-3). Only priority species should be examined when comparing across areas, as these were the only species consistently recorded by all observers. A total of 42.2 kilometers (26.2 mi) were monitored in 2012, all in Black Canyon of the Gunnison NP.

3.2.2 2010–2012 results

A total of 3,043 infestations, 2,936 of which were priority species, were detected along monitoring routes from 2010 to 2012 (Tables 3-2 and 3-3, Report Appendix A, Edvarchuk et al. 2012; Perkins 2012). Canada thistle (*Breea arvensis*), common mullein (*Verbascum thapsus*), musk thistle (*Carduus nutans*), reed canarygrass (*Phalaris arundinacea*), Russian thistle (*Salsola australis*), and kochia (*Bassia sieversiana*) were the most commonly detected priority IEPs (Table 3-3, Report Appendix A). Only priority species should be examined when comparing across areas, as these were the only species consistently recorded by all observers.

At BLCA, the highest IEP rates were found along stretches of the Gunnison River (up to 10.19/ha near the East Portal), East Portal Road (3.90/ha), and Red Rock Canyon (3.31/ha). Trails generally had few infestations, with a total rate of 0.29/ha along more than 20 km of trails. All of the roads on the North Rim also had low rates, with the highest being 1.36/ha along 4WD Road 10 (Table 3-2). Of the 2,936 priority infestations, 31% were classified as infestations larger than size class 2 (>40 m^2) (Table 3-3).

Priority IEPs were found in high numbers in some areas surrounding Blue Mesa Reservoir (up to 12.29/infestations ha), Elk Creek Campground (10.88/ha), Cooper/Neversink Area (7.49/ha), and Cooper Ranch Trail (8.93/ha) at CURE. Relatively few infestations were found along some areas surrounding Blue Mesa Reservoir (as low as 0.00/ha) and along most trails (Crystal Creek, Curecanti Creek, Dillon Pinnacles, Hermits Rest, Neversink, and Pine Creek trails all had less than 1.00/ha) at CURE (Table 3-2).

Only 12 tree infestations of three priority invasive tree species were detected: Russian olive, tamarisk, and Siberian elm (*Ulmus pumila*). Seven of these infestations were saplings, two were seedlings, and three were mature trees.

3.3 Monitoring transects

3.3.1 2012 results

A total of 81 transects were sampled in 2012 (data are included in Table 3-4, Electronic Appendix B). Spotted knapweed and Canada thistle had the highest percent covers, with 4.2% along the Corral Service Road and 1% along Drainage 12. Musk thistle and Canada thistle were also detected in transects but had less than 1% cover.

3.3.2 2010–2012 results

A total of 425 transects were sampled from 2010 to 2012 (Edvarchuk et al. 2012; Perkins 2012). At Blue Mesa Reservoir, yellow sweetclover (*Melilotus officinalis*) and Canada thistle had the highest percent covers (2.95% and 0.39% cover, respectively; Table 3-4). Overall, there was 4.06% cover of invasive species along the shoreline of Blue Mesa Reservoir. The Gunnison River and Red Rock Canyon had the highest invasive covers, of 7.63% and 2.33%, respectively. Almost all of that cover was reed canarygrass, with 7.58% and 1.67% cover (Table 3-4). All other areas had total percent cover of invasives at 0.25% or less.

3.4 Results comparison: 2003–2004 and 2010–2012

Black Canyon of the Gunnison NP was last intensively surveyed for IEPs in 2003 and 2004 (Dewey and Anderson 2005). Methods differed slightly between that project and this one, and it should be noted that mapping is subjective.[1] Therefore, although general comparisons and species with major differences between the two survey periods are useful (if somewhat problematic) and likely represent biological differences, smaller changes may not reflect actual conditions.

Nineteen species were on both the priority list of Dewey and Anderson (2005) and on our priority list. Of those 19, 11 were found during one of two time periods. The Gunnison River and Red Rock Canyon had 24% and 40% fewer infestations, respectively. Bull thistle and common mullein declined the most along the Gunnison River, and Canada thistle and common mullein declined the most along Red Rock Canyon (Table 3-5). However, infestations along the East Portal Road increased by 33%, with Canada thistle, musk thistle, and common mullein showing the biggest increases. The North Rim roads, South Rim Road, and trails all had similar numbers of infestations in 2003–2004 and 2010–2012.

[1]For example, one observer may identify two small infestations separated by 45 m (the patch separation rule is 50 m, but exact measurements are not made in the field) as two infestations, while another observer may identify them as one large infestation.

Table 3-1. Invasive exotic plants detected at Black Canyon of the Gunnison NP and Curecanti NRA, 2010–2012.

Scientific name	Common name	Method detected		Priority?
		Routes	Transects	
Acosta diffusa	diffuse knapweed	X		Yes
Acosta maculosa	spotted knapweed	X	X	Yes
Acroptilon repens	Russian knapweed	X	X	Yes
Arctium minus	common burdock	X		Yes
Bassia sieversiana	kochia	X	X	Yes
Breea arvensis	Canada thistle	X	X	Yes
Cardaria latifolia	perennial pepperweed	X		Yes
Cardaria spp.	whitetop	X		Yes
Carduus nutans	musk thistle	X	X	Yes
Cirsium vulgare	bull thistle	X		Yes
Cynoglossum officinale	houndstongue	X		Yes
Elaeagnus angustifolia	Russian olive	X		Yes
Hesperis matronalis	Dame's rocket	X		Yes
Iva xanthifolia	marsh elder	X		Yes
Leucanthemum vulgare	ox-eye daisy	X	X	Yes
Linaria vulgaris	yellow toadflax	X		Yes
Matricaria perforata	scentless chamomile	X	X	Yes
Phalaris arundinacea	reed canarygrass	X	X	Yes
Salsola australis	Russian thistle	X	X	Yes
Tamarix ramosissima	tamarisk	X		Yes
Ulmus pumila	Siberian elm	X		Yes
Verbascum thapsus	common mullein	X	X	Yes
Agropyron cristatum	crested wheatgrass		X	No
Anisantha tectorum	cheatgrass		X	No
Bromus inermis	smooth brome		X	No
Chorispora tenella	blue mustard	X		No
Lycium barbarum	matrimony vine	X		No
Melilotus officinalis	yellow sweetclover		X	No
Poa pratensis	Kentucky bluegrass		X	No
Rumex crispus	curly dock		X	No
Sisymbrium altissimum	tumble mustard		X	No
Clematis orientalis	Chinese clematis	X		In 2010 only
Convolvulus arvensis	field bindweed	X	X	In 2010 only

Shaded species were found during the 2012 monitoring efforts.

Table 3-2. Number of IEP infestations and infestations/ha by route and route type, Black Canyon of the Gunnison NP and Curecanti NRA, 2010–2012.

Route	Length (m)	Area (ha)	Infestations		Infestations/ha	
			Total	Priority only	Total	Priority only
Black Canyon of the Gunnison NP						
Riparian						
Gunnison River 1	1,946.9	22.74	50	49	2.20	2.15
Gunnison River 2	2,012.7	24.97	93	93	3.73	3.73
Gunnison River 3	1,011.9	7.29	5	5	0.69	0.69
Gunnison River 4	458.0	2.01	8	8	3.98	3.98
Gunnison River 5	2,796.0	30.26	117	116	3.87	3.83
Gunnison River 6*	2,396.8	15.30	156	156	10.19	10.19
Gunnison River total	*10,622.3*	*102.57*	*429*	*427*	*4.18*	*4.16*
Drainage 1	**1,782.1**	**10.60**	**16**	**16**	**1.51**	**1.51**
Drainage 9	**2,571.7**	**10.23**	**14**	**14**	**1.37**	**1.37**
Drainage 12	**2,190.5**	**6.64**	**12**	**12**	**1.81**	**1.81**
Drainage 14	**3,025.2**	**10.61**	**5**	**5**	**0.47**	**0.47**
Drainage 15	**2,074.4**	**6.27**	**13**	**13**	**2.07**	**2.07**
Grizzly Gulch	**7,543.5**	**43.94**	**49**	**49**	**1.12**	**1.12**
Red Rock Canyon	5,007.1	68.37	248	226	3.63	3.31
Riparian total	*24,194.1*	*156.66*	*357*	*335*	*2.28*	*2.14*
Trails						
Cross Fissures	313.7	1.37	0	0	0.00	0.00
Deadhorse	4,103.9	9.82	13	12	1.32	1.22
Gunnison Route	1,098.2	5.18	0	0	0.00	0.00
Island Peaks	366.6	1.82	0	0	0.00	0.00
Long Draw	701.1	3.17	7	7	2.21	2.21
North Vista	**5,724.7**	**24.09**	**0**	**0**	**0.00**	**0.00**
Rim Rock	848.4	4.67	2	2	0.43	0.43
Rock Point	289.8	1.64	0	0	0.00	0.00
Slide Draw Route	968.3	5.29	1	1	0.19	0.19
SOB Route	2,230.8	19.91	12	12	0.60	0.60
Tomichi Route	780.9	10.55	1	1	0.09	0.09
Warner Point Nature	1,066.1	9.66	0	0	0.00	0.00
Warner Route	2,000.8	22.20	0	0	0.00	0.00
Trails total	*20,493.3*	*119.37*	*36*	*35*	*0.30*	*0.29*
Roads						
Black Canyon	**5,418.2**	**36.45**	**46**	**43**	**1.26**	**1.18**
Closed	**2,710.8**	**14.55**	**15**	**13**	**1.03**	**0.89**
Corral Service	**873.0**	**3.88**	**7**	**7**	**1.80**	**1.80**
East Portal	7,467.3	62.88	279	245	4.44	3.90
North Rim Rod	7,680.4	65.96	32	17	0.49	0.26
Service 1	**4,790.3**	**22.68**	**16**	**16**	**0.71**	**0.71**
Service 2	**1,532.1**	**8.32**	**3**	**3**	**0.36**	**0.36**
South Rim	13,525.8	60.76	26	16	0.43	0.26
4WD 1	**1,190.7**	**9.26**	**1**	**1**	**0.11**	**0.11**
4WD 5	**376.0**	**2.07**	**0**	**0**	**0.00**	**0.00**
4WD 10	**435.9**	**1.47**	**2**	**2**	**1.36**	**1.36**
Roads total	*46,000.5*	*288.28*	*427*	*363*	*1.48*	*1.26*
Black Canyon total	**101,310.2**	**666.88**	**1,249**	**1,160**	**1.87**	**1.74**

Table 3-2. Number of IEP infestations and infestations/ha by route and route type, Black Canyon of the Gunnison NP and Curecanti NRA, 2010–2012, cont.

Route	Length (m)	Area (ha)	Infestations		Infestations/ha	
			Total	Priority only	Total	Priority only
Curecanti NRA						
Reservoir						
Blue Mesa 1	142,575.4	856.60	1,154	1,149	1.35	1.34
Blue Mesa 2	584.3	1.15	5	5	4.36	4.36
Blue Mesa 3	847.4	1.71	21	21	12.29	12.29
Blue Mesa 4	364.5	1.74	0	0	0.00	0.00
Blue Mesa 5	409.3	1.14	3	3	2.63	2.63
Blue Mesa 6	1,473.4	4.50	4	4	0.89	0.89
Blue Mesa 7	1,392.9	5.54	25	25	4.51	4.51
Reservoir total	*147,647.2*	*872.38*	*1,212*	*1,207*	*1.39*	*1.38*
Extra Area						
Neversink/Cooper	NA	23.37	175	175	7.49	7.49
Roads						
Elk Creek Access	606.9	4.39	7	7	1.59	1.59
Elk Creek Campground	3,134.1	18.66	206	203	11.04	10.88
Elk Creek Main	1,277.1	8.61	12	8	1.39	0.93
East Portal	3,799.2	33.15	106	104	3.20	3.13
Roads total	*8,817.3*	*64.87*	*331*	*322*	*3.76*	*3.63*
Trails						
Cooper Ranch River	265.2	3.59	7	7	1.95	1.95
Cooper Ranch Trail	311.5	2.13	19	19	8.93	8.93
Crystal Creek	2,494.7	16.77	0	0	0.00	0.00
Curecanti Creek	3,063.9	19.81	7	7	0.35	0.35
Dillon Pinnacles	3,133.4	25.30	14	12	0.55	0.47
Hermits Rest	4,050.0	26.65	3	3	0.11	0.11
Mesa Creek	1,164.9	5.67	9	7	1.59	1.23
Neversink	912.7	5.75	5	5	0.87	0.87
Pine Creek	2,011.0	13.91	12	12	0.86	0.86
Trails total	*17,407.4*	*119.58*	*76*	*72*	*1.69*	*1.64*
Curecanti total	**173,871.9**	**1,080.20**	**1,794**	**1,776**	**1.66**	**1.64**
BLCA/CURE total	**275,182.1**	**1747.08**	**3,043**	**2,936**	**1.74**	**1.68**

*Includes 183.6 m and 1.53 ha located in CURE.

Bolded routes were surveyed in 2012.

Table 3-3. Number of infestations by species and infestation size class detected along monitoring routes, Black Canyon of the Gunnison NP and Curecanti NRA, 2010–2012.

Scientific name	Common name	Total infestations		Infestation size class (2010–2012)				
		2012	2010–2012	1	2	3	4	5
Priority species								
Breea arvensis	Canada thistle	13	641	54	140	279	90	79
Verbascum thapsus	common mullein	22	631	137	187	186	27	94
Carduus nutans	musk thistle	87	530	182	167	159	15	7
Phalaris arundinacea	reed canarygrass	1	358	5	42	178	91	42
Salsola australis	Russian thistle	29	224	21	25	71	77	30
Bassia sieversiana	kochia	1	202	1	6	69	94	31
Matricaria perforata	scentless chamomile	0	61	18	9	25	6	3
Cirsium vulgare	bull thistle	0	58	37	15	5	1	0
Arctium minus	common burdock	1	57	27	16	11	2	1
Linaria vulgaris	yellow toadflax	0	55	2	10	17	8	18
Acosta maculosa	spotted knapweed	28	29	7	7	13	2	0
Acroptilon repens	Russian knapweed	7	22	4	7	5	4	2
Leucanthemum vulgare	ox-eye daisy	0	16	0	6	6	4	0
Hesperis matronalis	Dame's rocket	0	15	12	3	0	0	0
Cardaria spp.	whitetop	0	12	1	7	4	0	0
Ulmus pumila	Siberian elm	1	7	3	2	2	0	0
Cardaria latifolia	perennial pepperweed	0	6	1	3	2	0	0
Tamarix ramosissima	tamarisk	2	6	5	1	0	0	0
Elaeagnus angustifolia	Russian olive	0	2	1	1	0	0	0
Iva xanthifolia	marsh elder	2	2	1	1	0	0	0
Acosta diffusa	diffuse knapweed	0	1	0	0	1	0	0
Cynoglossum officinale	houndstongue	0	1	0	0	1	0	0
Non-priority species (or not a priority species in all years)**								
Convolvulus arvensis	field bindweed	0	99	0	37	47	11	4
Chorispora tenella	blue mustard	5	5	0	3	2	0	0
Clematis orientalis	Chinese clematis	0	2	0	1	1	0	0
Lycium barbarum	matrimony vine	0	1	0	1	0	0	0
Priority species		**194**	**2,936**	**519**	**655**	**1,034**	**421**	**307**
All species		**199**	**3,043**	**519**	**697**	**1,084**	**432**	**311**

*Infestation size classes: 1 = 1–a few plants (≤2 × 2 m), 2 = few plants–40 m^2 (48 yd^2), 3 = 40–400 m^2 (48–478 yd^2), 4 = 400–1,000 m^2 (0.1–0.25 acre), 5 = 1,000–2,000 m^2 (0.25–0.5 acre).

**These species 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, Black Canyon of the Gunnison NP and Curecanti NRA, 2010–2012.

		North Rim Roads		South Rim Road		Blue Mesa Reservoir		Gunnison River		Red Rock Canyon	
Scientific name	**Common name**	**Detected (36)**	**Percent cover (SE)**	**Detected (16)**	**Percent cover (SE)**	**Detected (133)**	**Percent cover (SE)**	**Detected (27)**	**Percent cover (SE)**	**Detected (10)**	**Percent cover (SE)**
Priority species											
Acroptilon repens	Russian knapweed	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	1	0.67 (0.67)
Acosta maculosa	spotted knapweed	1	0.12 (0.12)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)
Anisantha tectorum	cheatgrass	0	0.00 (0.00)	1	0.19 (0.19)	13	0.07 (0.02)	0	0.00 (0.00)	0	0.00 (0.00)
Bassia sieversiana	kochia	0	0.00 (0.00)	0	0.00 (0.00)	7	0.25 (0.13)	0	0.00 (0.00)	0	0.00 (0.00)
Breea arvensis	Canada thistle	0	0.00 (0.00)	0	0.00 (0.00)	19	0.39 (0.12)	1	0.01 (0.01)	0	0.00 (0.00)
Carduus nutans	musk thistle	1	<0.01 (<0.01)	0	0.00 (0.00)	1	<0.01 (<0.01)	0	0.00 (0.00)	0	0.00 (0.00)
Leucanthemum vulgare	ox-eye daisy	0	0.00 (0.00)	0	0.00 (0.00)	1	<0.01 (<0.01)	0	0.00 (0.00)	0	0.00 (0.00)
Matricaria perforata	scentless chamomile	0	0.00 (0.00)	0	0.00 (0.00)	2	0.01 (0.01)	0	0.00 (0.00)	0	0.00 (0.00)
Phalaris arundinacea	reed canarygrass	0	0.00 (0.00)	0	0.00 (0.00)	0	0.00 (0.00)	11	7.58 (2.61)	2	1.67 (1.34)
Rumex crispus	curly dock	0	0.00 (0.00)	0	0.00 (0.00)	4	0.04 (0.02)	0	0.00 (0.00)	0	0.00 (0.00)
Salsola australis	Russian thistle	1	0.01 (0.01)	0	0.00 (0.00)	2	0.03 (0.03)	0	0.00 (0.00)	0	0.00 (0.00)
Verbascum thapsus	common mullein	0	0.00 (0.00)	0	0.00 (0.00)	13	0.31 (0.16)	1	0.02 (0.02)	0	0.00 (0.00)
Total priority species[a]		**3**	**0.13 (0.12)**	**1**	**0.19 (0.19)**	**46**	**4.06 (0.63)**	**11**	**7.63 (2.61)**	**3**	**2.33 (1.41)**
Non-priority species[b]											
Agropyron cristatum	crested wheatgrass	0	0.00 (0.00)	1	0.06 (0.06)	0	<0.01 (<0.01)	0	0.00 (0.00)	0	0.00 (0.00)
Melilotus officinalis	yellow sweetclover	0	0.00 (0.00)	0	0.00 (0.00)	44	2.95 (0.63)	1	0.01 (0.01)	0	0.00 (0.00)
Sisymbrium altissimum	tumble mustard	0	0.00 (0.00)	0	0.00 (0.00)	1	0.01 (0.01)	0	0.00 (0.00)	0	0.00 (0.00)
Total non-priority species		**0**	0.00 (0.00)	**1**	**0.06 (0.06)**	**45**	**2.96 (0.63)**	**1**	**0.01 (0.01)**	**0**	**0.00 (0.00)**

[a]Some transects may have contained more than one IEP.

[b]May not have been recorded by all observers.

Surveys were conducted July 5–August 21, 2011, and August 1–3, 2012.

There were no invasives detected in transects (number of plots in parentheses) at Dead Horse Trail (8), Dillon Pinnacles Trail (2), Hermits Rest Trail (8), or Neversink Trail (2) from 2010 to 2012. On the Pine Creek Trail, invasives were detected on 1 of 3 transects. Invasives were detected on 1 of 1 transect on Slide Draw. In both cases, total invasive percent cover was less than 1.25%.

Table 3-5. Priority species observed and size of infestations detected in 2003–2004, compared to data collected along the same routes in 2010–2012.

		Number of infestations																	
		Gunnison River			Red Rock Canyon			East Portal Road			South Rim Road			North Rim Roads[b]			Trails[c]		
Scientific name	Common name	2003–2004	2010–2012	Change	2003–2004	2010–2012	Change	2003–2004	2010–2012	Change	2003–2004	2010–2012	Change	2003–2004	2010–2012	Change	2003–2004	2010–2012	Change
Acosta maculosa	spotted knapweed	0	0	0%	0	0	0%	0	0	0%	0	0	0%	2	1	-50%	0	0	0%
Acroptilon repens	Russian knapweed	0	0	0%	0	2	NEW	0	4	NEW	0	0	0%	5	3	-40%	0	0	0%
Arctium minus	common burdock	9	11	+22%	52	42	-19%	3	0	-100%	1	0	-100%	0	0	0%	0	0	0%
Breea arvensis	Canada thistle	44	55	+25%	48	11	-77%	32	61	+91%	7	4	-43%	6	5	-17%	0	0	0%
Carduus nutans	musk thistle	20	2	-90%	47	59	+26%	52	84	+62%	2	5	+150%	33	31	-6%	0	0	0%
Cirsium vulgare	bull thistle	34	14	-59%	1	1	0%	25	0	-100%	1	0	-100%	0	1	NEW	0	0	0%
Iva xanthifolia	marsh elder	0	0	0%	0	0	0%	0	0	0%	0	0	0%	3	0	-100%	0	0	0%
Linaria vulgaris	yellow toadflax	4	1	-75%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Salsola australis[a]	Russian thistle	0	0	0%	0	7	NEW	0	0	0%	0	0	0%	15	18	+20%	0	0	0%
Tamarix chinensis	tamarisk	8	2	-75%	1	0	-100%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Ulmus pumila	Siberian elm	3	0	-100%	0	0	0%	0	1	NEW	0	0	0%	0	0	0%	0	0	0%
Verbascum thapsus	common mullein	104	86	-17%	77	13	-83%	72	95	+32%	7	7	0%	1	0	-100%	7	8	+14%
Priority totals		226	171	**-24%**	226	135	**-40%**	184	245	**+33%**	18	16	**-11%**	65	59	**-9%**	7	8	**+14%**

[a] Not listed as a priority in 2003 and 2004 but was recorded along the North Rim Roads.

[b] Black Canyon and North Rim Roads

[c] North Vista, Warner Point Nature, Tomichi Route, Cross Fissures, and Long Draw

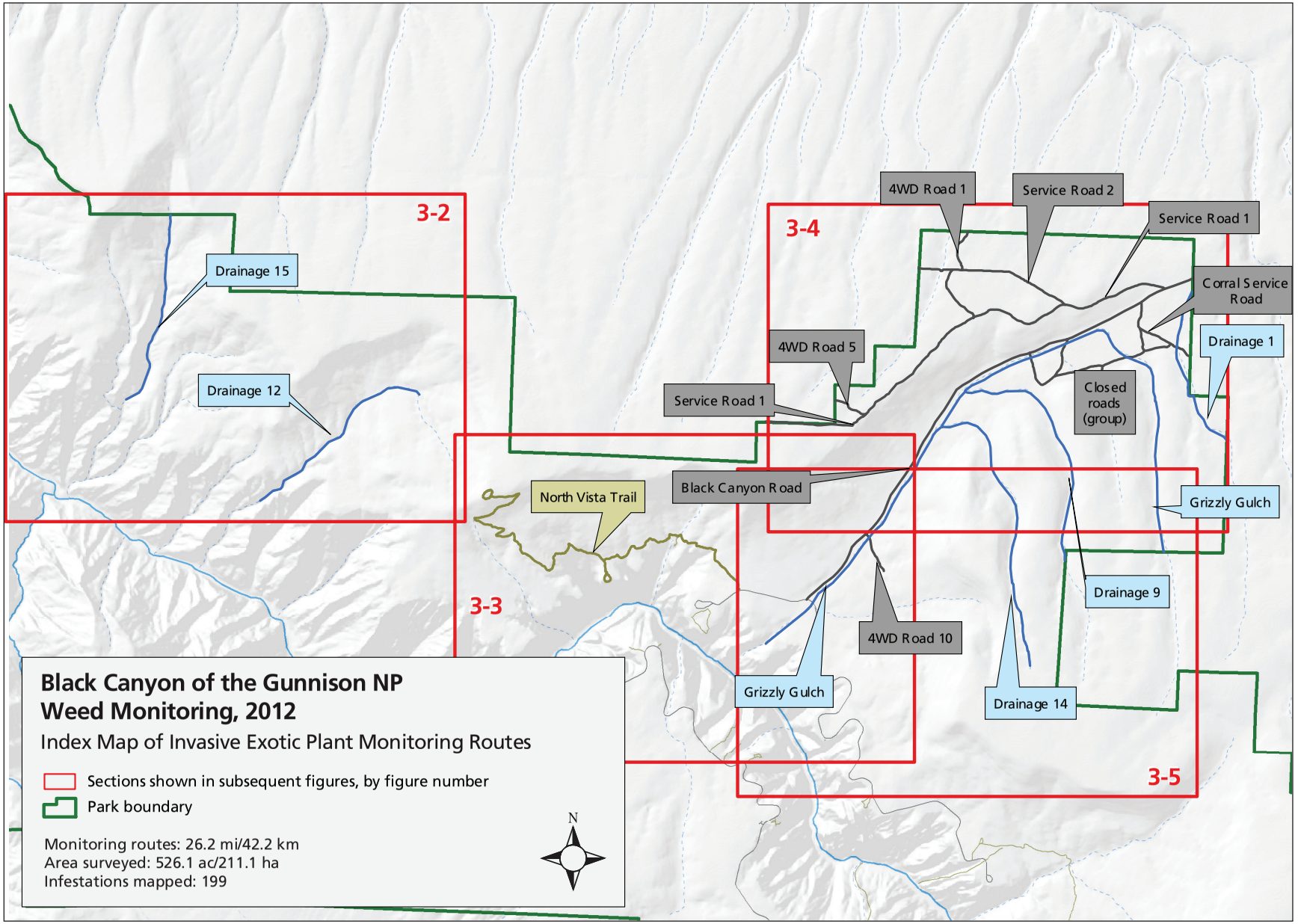


Figure 3-1. Index map of invasive plant monitoring routes, Black Canyon of the Gunnison NP, August 1–3, 2012.

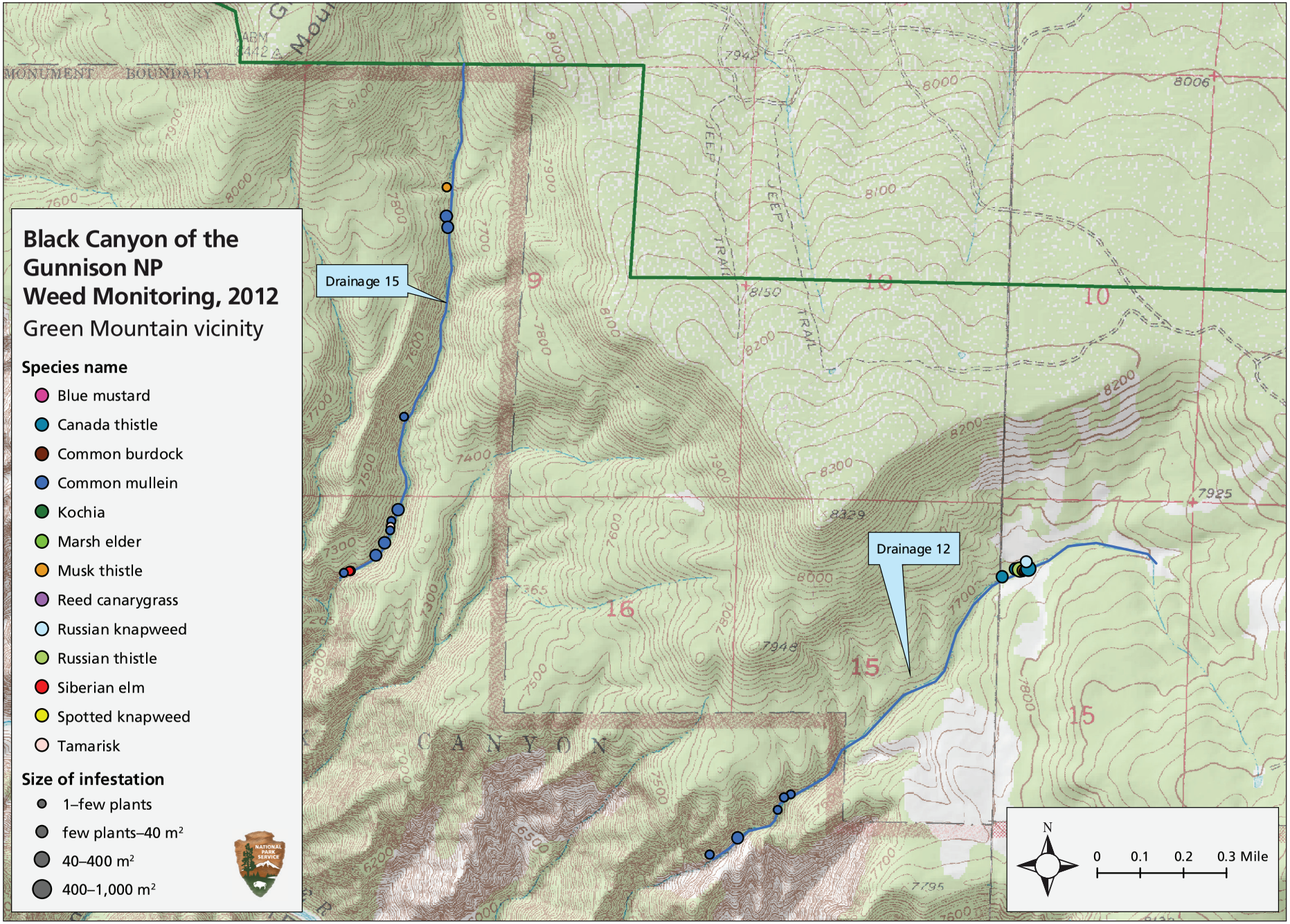


Figure 3-2. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of Green Mountain, Black Canyon of the Gunnison NP, August 1–3, 2012.

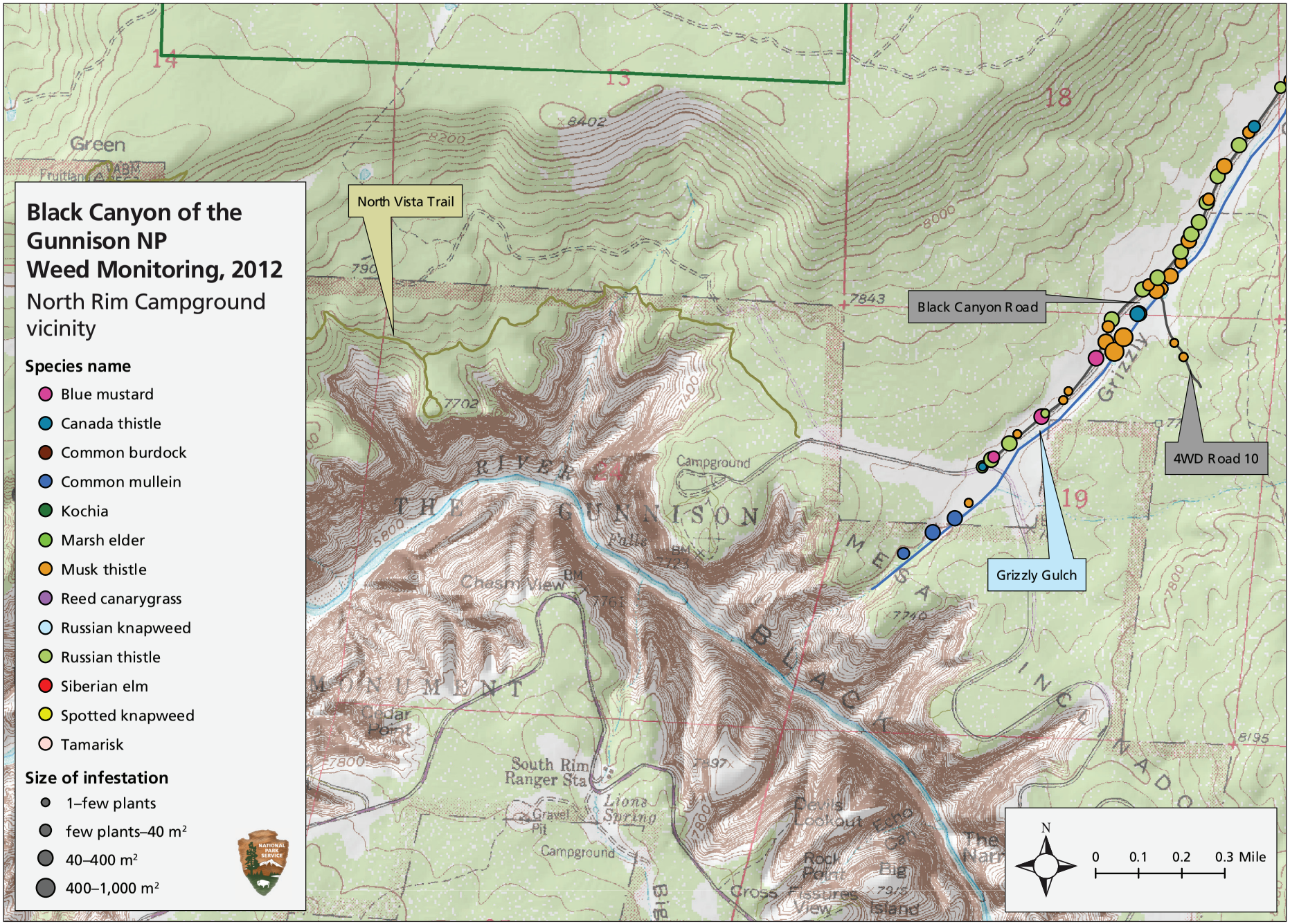


Figure 3-3. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of the North Rim Campground, Black Canyon of the Gunnison NP, August 1–3, 2012.

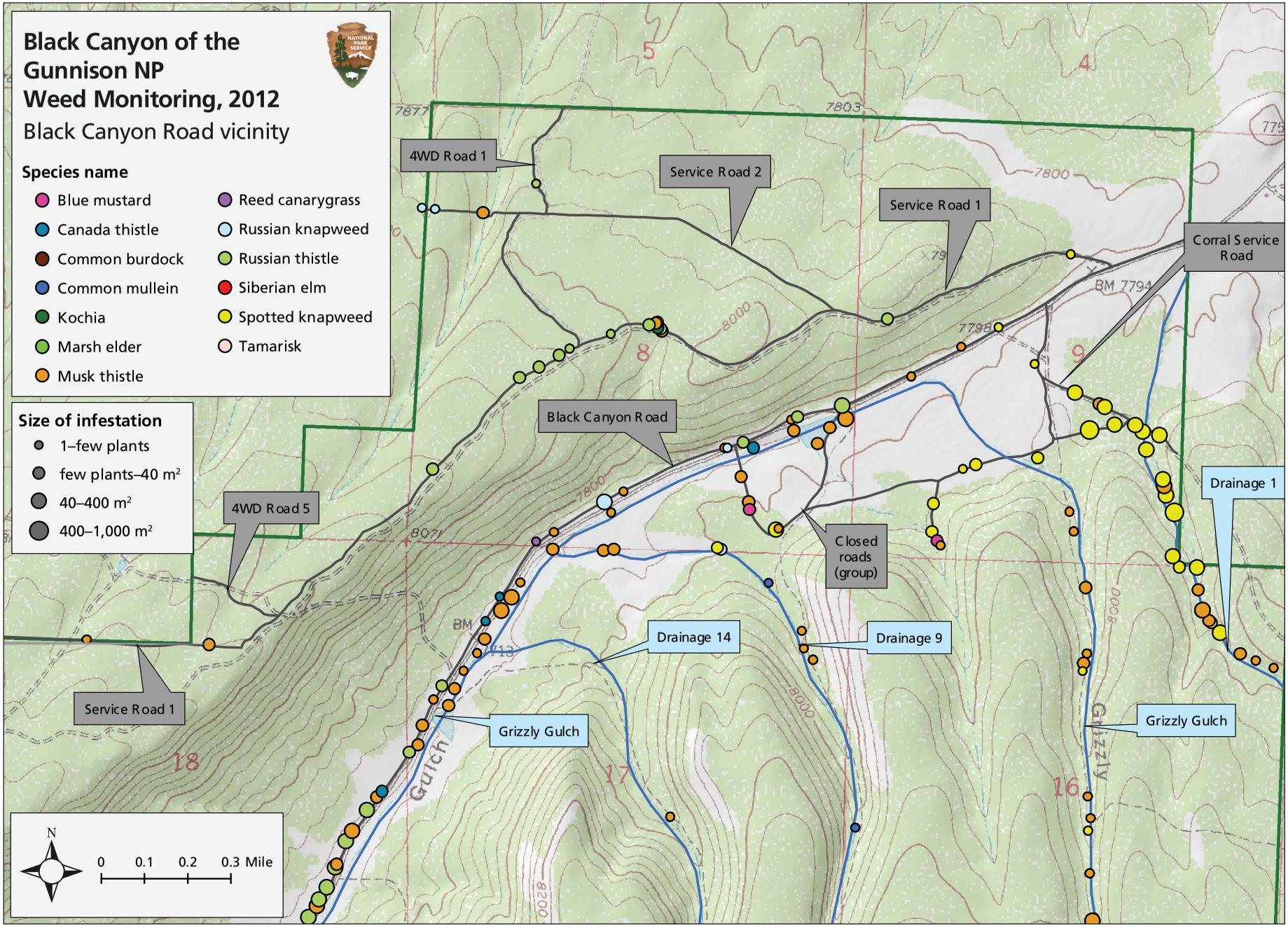


Figure 3-4. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of the Black Canyon Road, Black Canyon of the Gunnison NP, August 1–3, 2012.

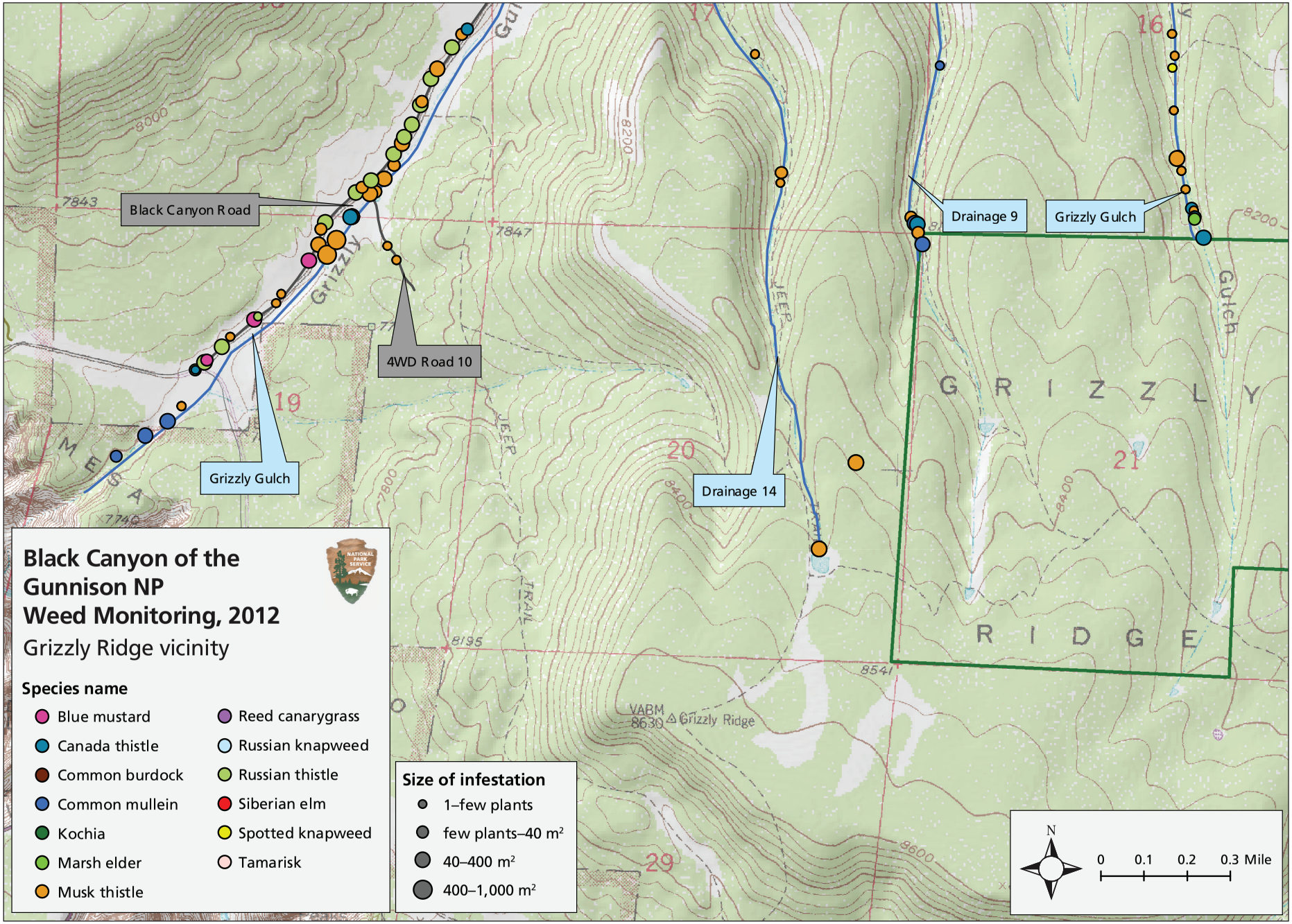


Figure 3-5. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of Grizzly Ridge, Black Canyon of the Gunnison NP, August 1–3, 2012.

4 Discussion

The NCPN will continue to work with BLCA/CURE staff and area weed experts to review and update the list of priority species each year. In 2014, the network will add yellow sweetclover to the priority list for BLCA and will add it to species monitoring in the transects for both parks. Presence and absence data for most priority species, and presence data for other species, should be reliable. However, absence data for non-priority species are suspect, because not all observers recorded all of these species.

In 2010–2012, priority IEPs were most widespread along the shores of Blue Mesa Reservoir, and reed canarygrass was widespread along the Gunnison River and in Red Rock Canyon. IEPs were generally low along trails, the South Rim Road, and the North Rim roads. Canada thistle, common mullein, musk thistle, reed canarygrass, Russian thistle, and kochia were the most common IEPs (see Table 3-3). All of these species, except for reed canarygrass, can be controlled with sufficient resources.

It is encouraging to see declines in infestations along the Gunnison River, Red Rock Canyon, and the upper portion of East Portal Road. All of these areas have been the focus of invasive control efforts. The increases in infestations along the East Portal Road suggest it may be time to direct eradication efforts there. However, control efforts cannot be conducted safely on foot for portions of this road due to steep terrain and sliding rocks. In these areas, it may be possible to work with the Bureau of Reclamation to do repel spraying, which can be performed from a vehicle rather than on foot. There are still large areas of the park where there are few infestations; efforts should be made to keep these areas free of priority invasive plants.

It should be noted that 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.

4.1 Survey design

IEPs at BLCA/CURE will generally be monitored at the same time of year, every other year. Consistency in timing of monitoring should ensure consistency in detection probabilities and cover estimates of most species. For many species, sampling any time from May through September is not expected to drastically alter the chances of detecting invasive species larger than the minimum detection target size. The NCPN will monitor invasive plants for two years out of three and then take one year off.

In 2014, the network will return to start a new monitoring rotation with a four-person crew working one pay period of 8–10-hour days. Depending on the route, a crew member can search 6–10 km per day. Survey times vary; less may be possible at BLCA, where many routes follow trails and drainages with only one way in and out. A proposed survey rotation is shown in Table 4-1; however, this schedule could be altered by sequestration or other budget cuts. Monitoring crews should start with high-priority areas and move toward low-priority areas (unless low-priority areas are located in close proximity to high-priority areas) (Table 4-1).

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 and cheatgrass by monitoring route. Extra-area surveys will also be considered for inventories at the park's request. The NCPN invasive plant monitoring protocol was submitted for peer review in December 2010 and comments were received in September 2012. It is expected that the protocol will be finalized in Fiscal Year 2013.

Table 4-1. Monitoring rotation for routes at Black Canyon of the Gunnison NP and Curecanti NRA.

Year	Route	Length (km)	Priority
2014	Elk Creek areas	5	High
2014	Cooper/Neversink area	5	High
2014	Blue Mesa Reservoir	148	Moderate (Blue Mesa 2 + 3 are high)
2014	Dillon Pinnacles and Pine Creek trails	5	Low
2014	**Total**	**163**	
2015	Gunnison River and associated trails/routes	23	High
2015	East Portal Road	11	Low (Geohazard safety concerns)
2015	North Rim roads	25	Moderate
2015	North Rim drainages	19	Moderate
2015	South Rim Road	14	Moderate
2015	North Rim trails (CURE and BLCA)	22	Low
2015	South Rim trails	3	Low
2015	**Totals**	**117**	

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Appendix A: Species Detected Along Monitoring Routes, Black Canyon of the Gunnison National Park and Curecanti National Recreation Area, 2010–2012, with Emphasis on the Six Most-Detected Species

Maps begin on next page

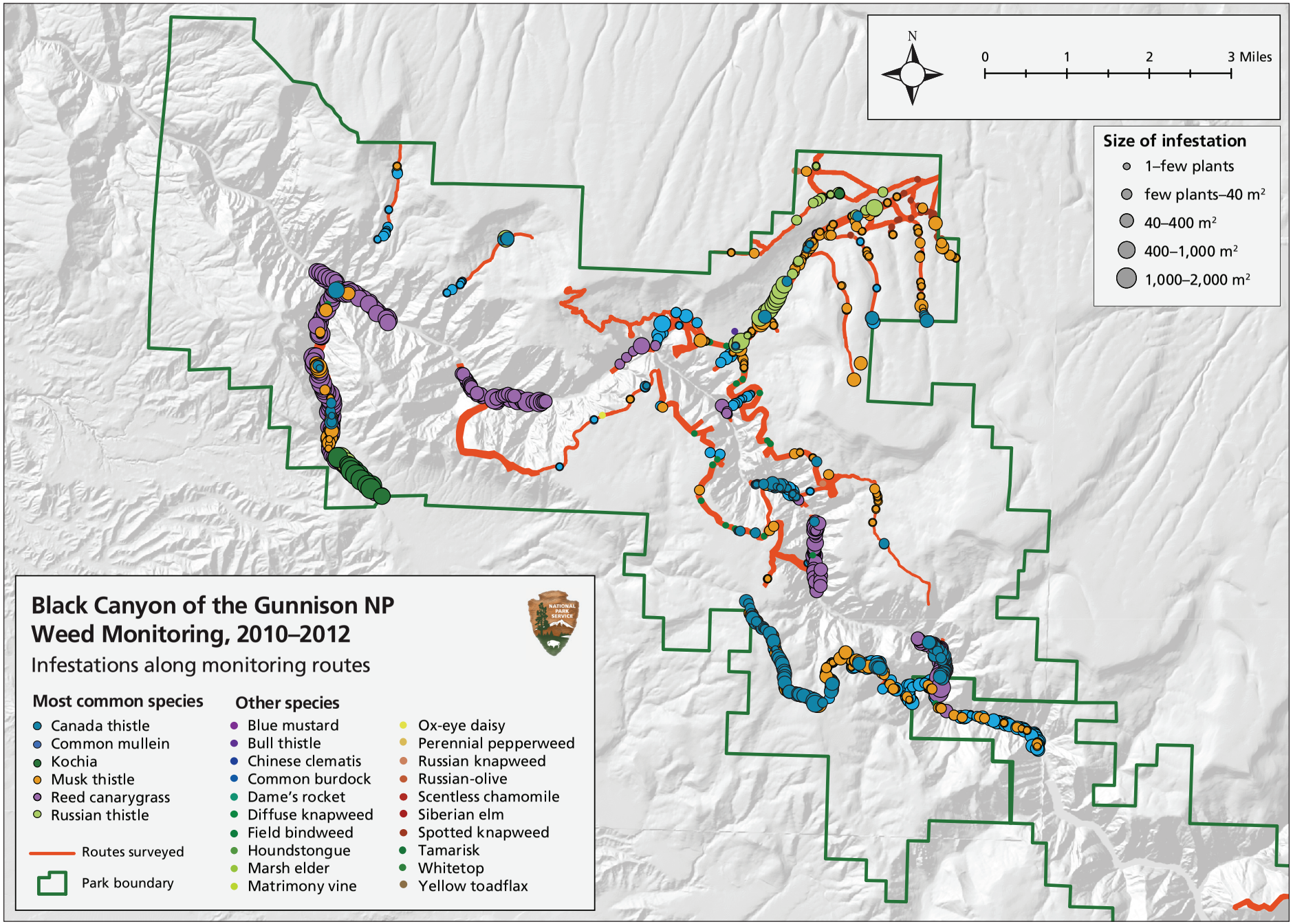


Figure A-1. Infestations along monitoring routes, Black Canyon of the Gunnison National Park, 2010–2012.

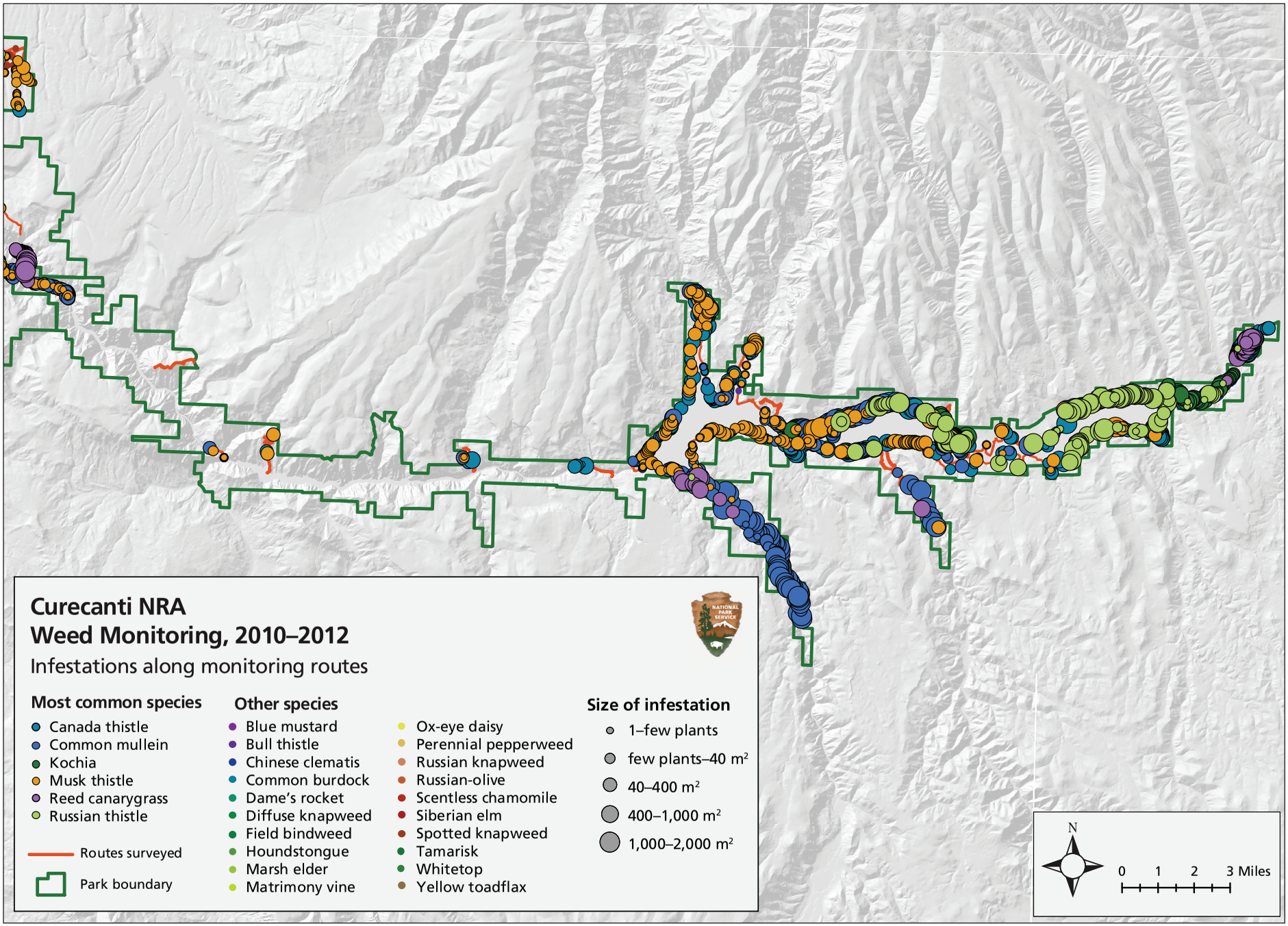


Figure A-2. Infestations along monitoring routes, Curecanti National Recreation Area, 2010–2012.

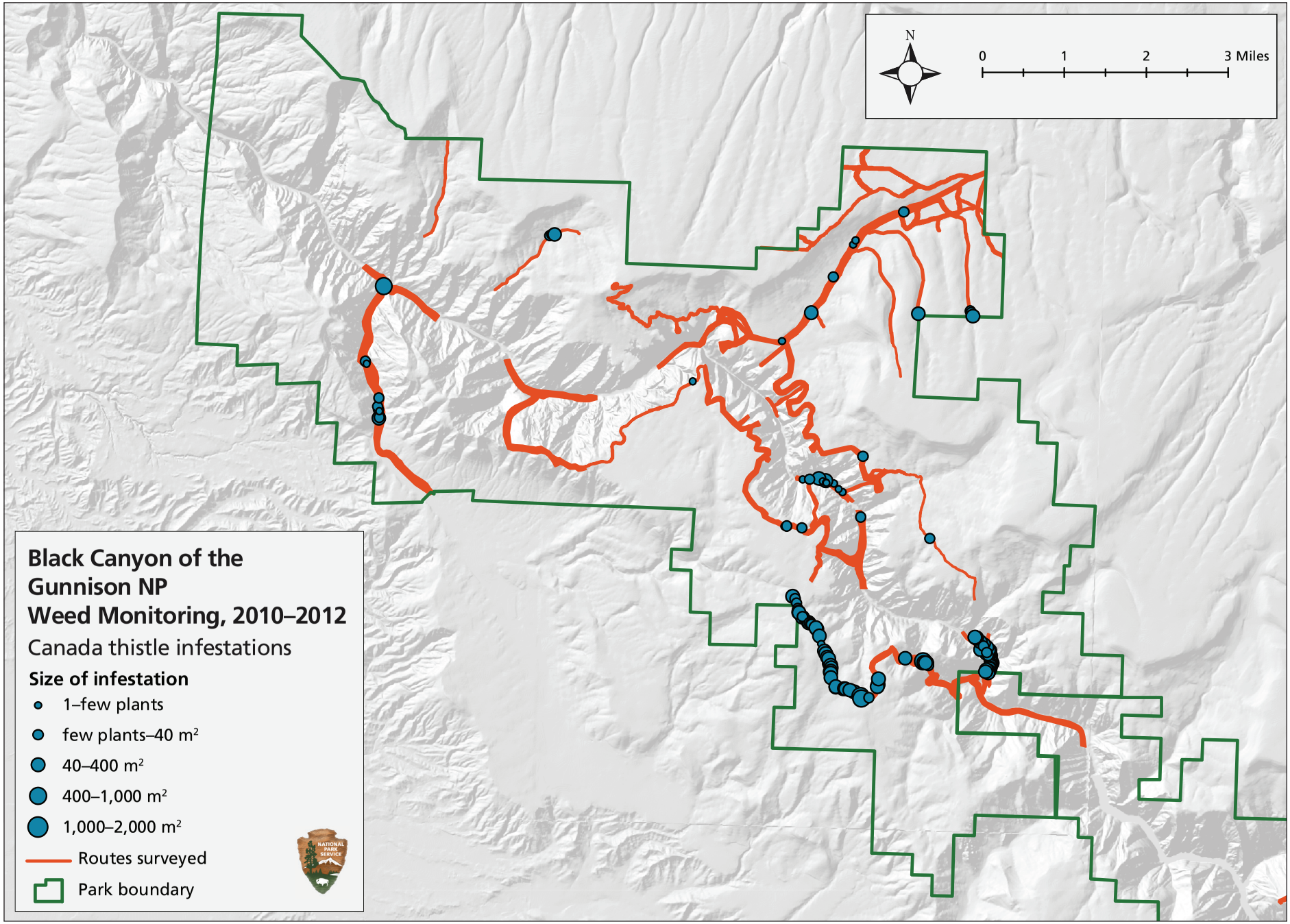


Figure A-3. Canada thistle infestations along monitoring routes, Black Canyon of the Gunnison National Park, 2010–2012.

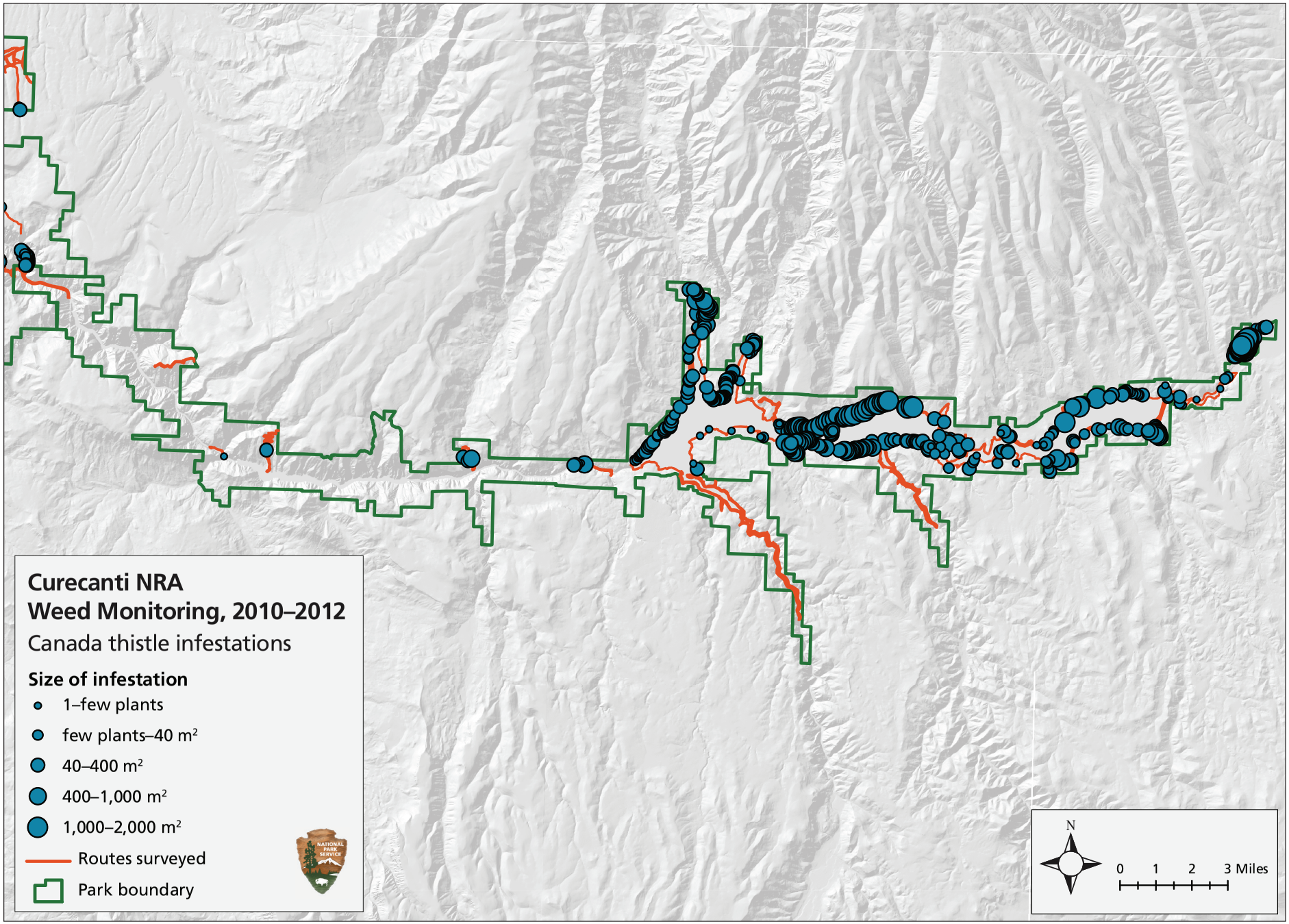


Figure A-4. Canada thistle infestations along monitoring routes, Curecanti National Recreation Area, 2010–2012.

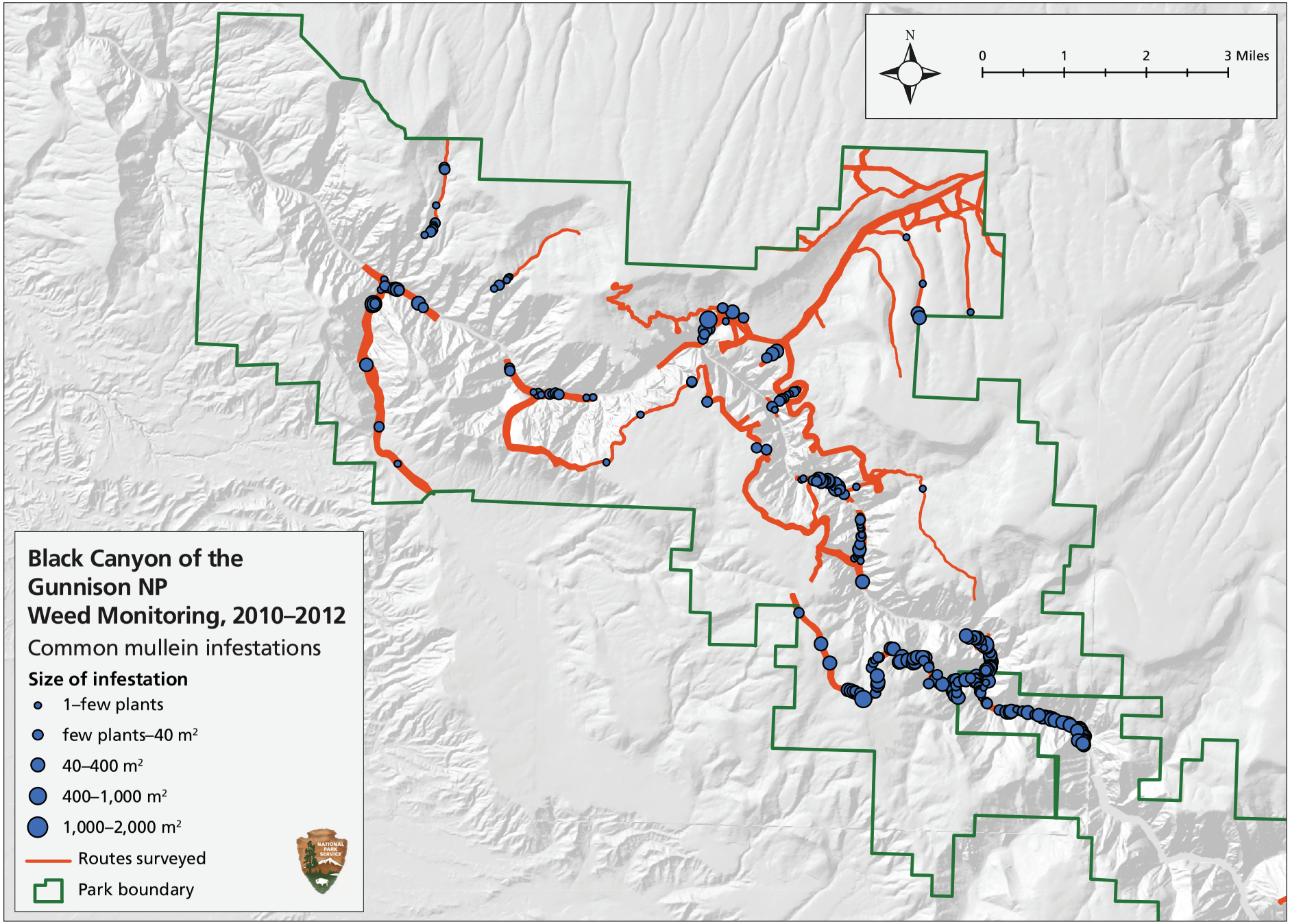


Figure A-5. Common mullein infestations along monitoring routes, Black Canyon of the Gunnison National Park, 2010–2012.

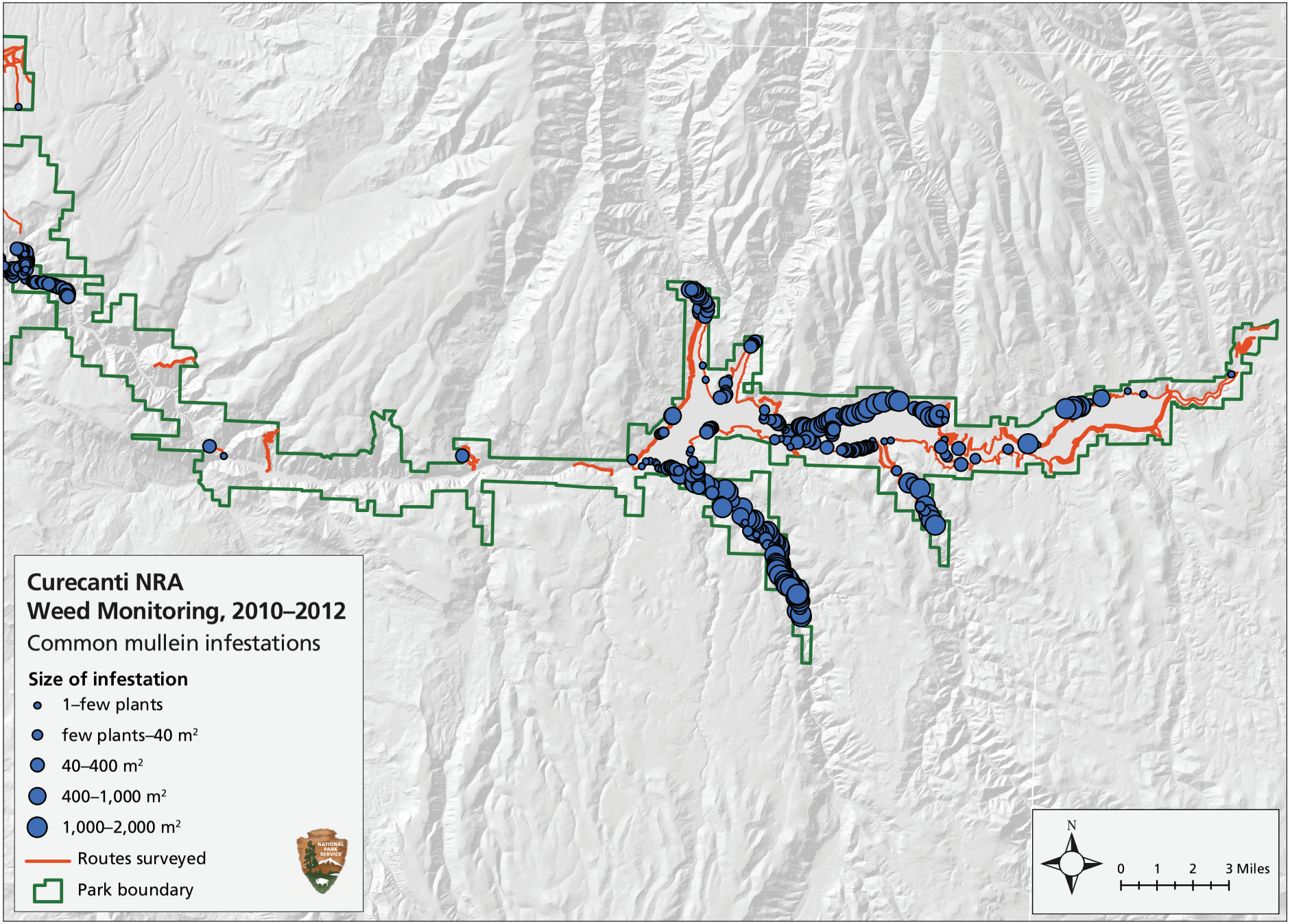


Figure A-6. Common mullein infestations along monitoring routes, Curecanti National Recreation Area, 2010–2012.

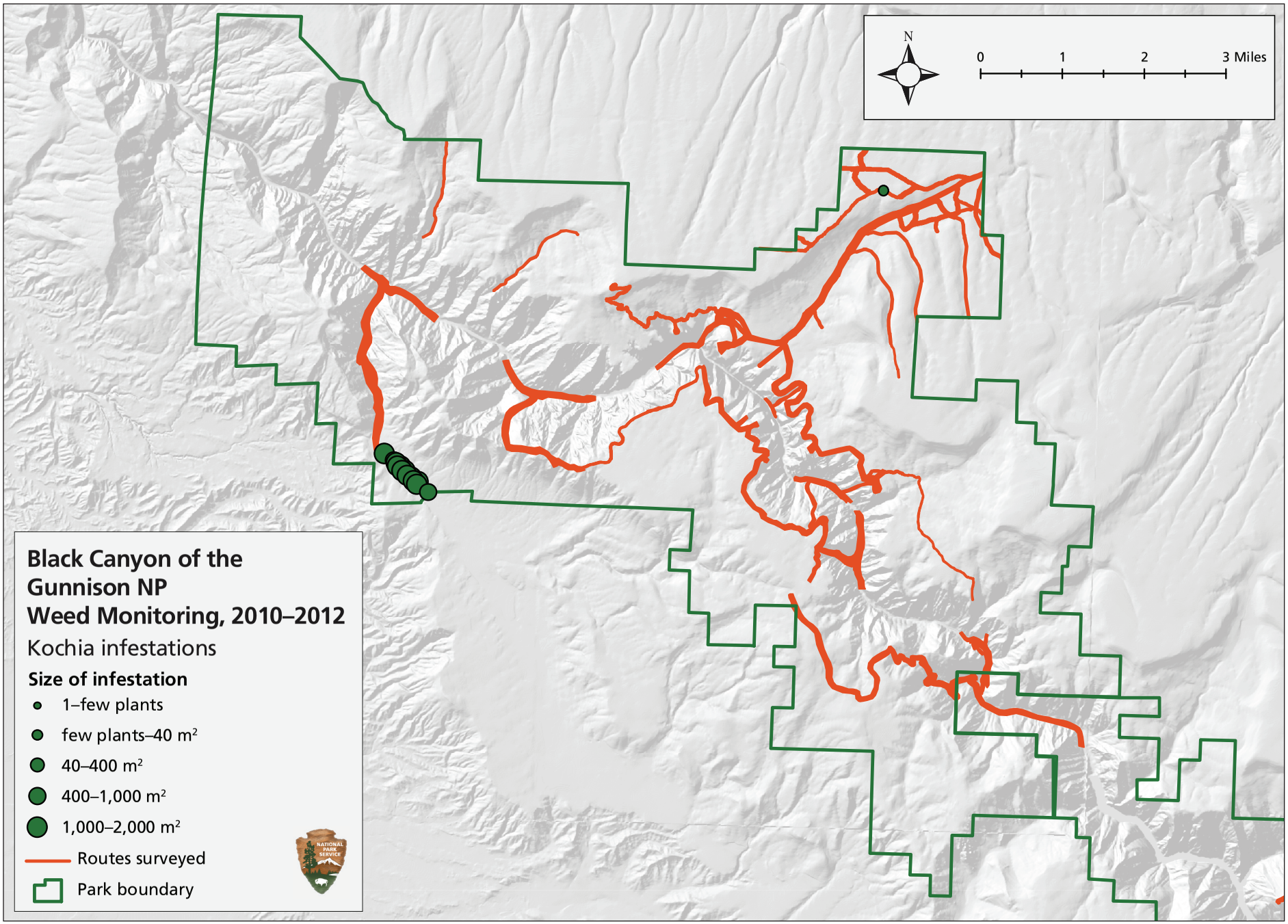


Figure A-7. Kochia infestations along monitoring routes, Black Canyon of the Gunnison National Park, 2010–2012.

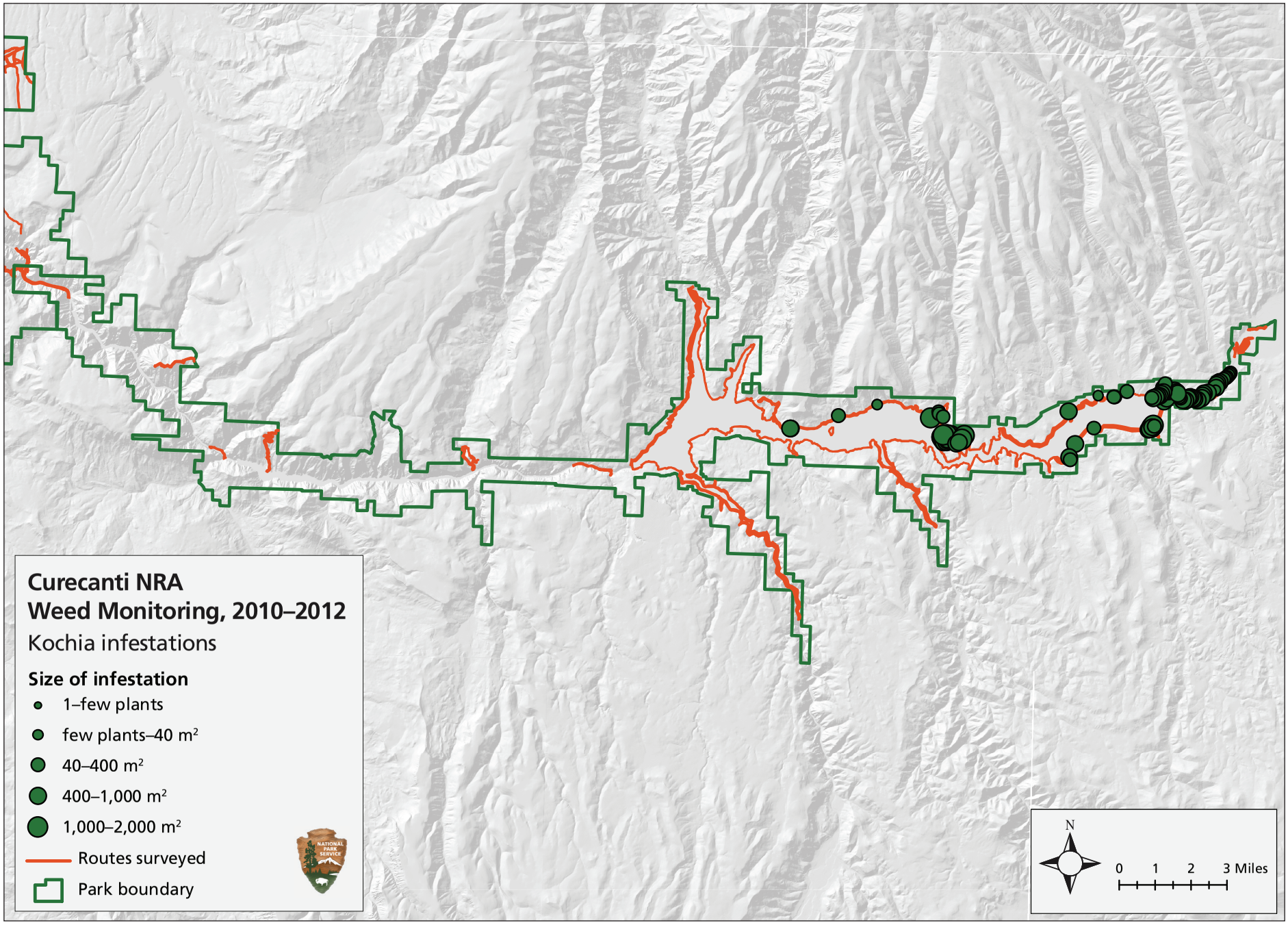


Figure A-8. Kochia infestations along monitoring routes, Curecanti National Recreation Area, 2010–2012.

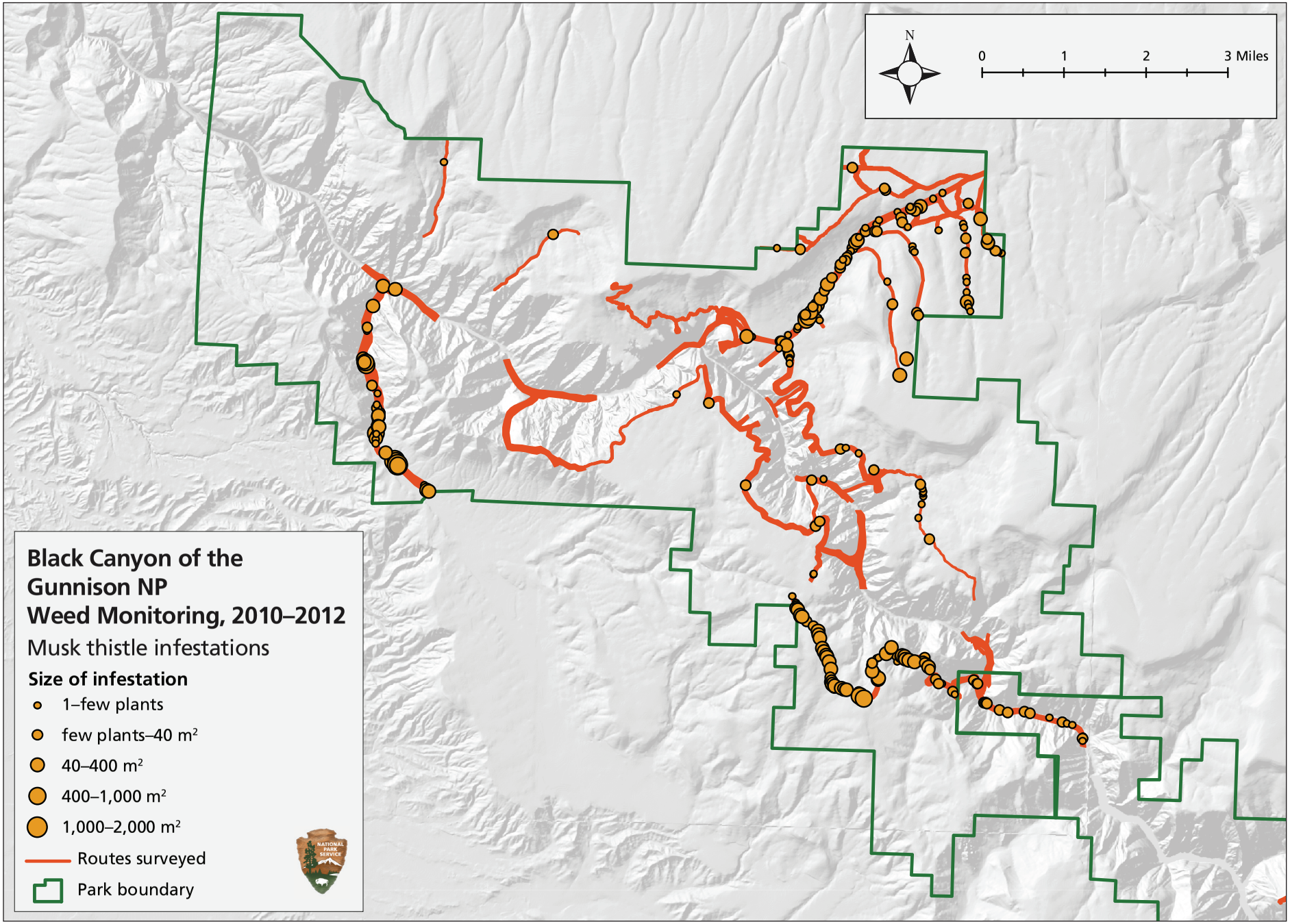


Figure A-9. Musk thistle infestations along monitoring routes, Black Canyon of the Gunnison National Park, 2010–2012.

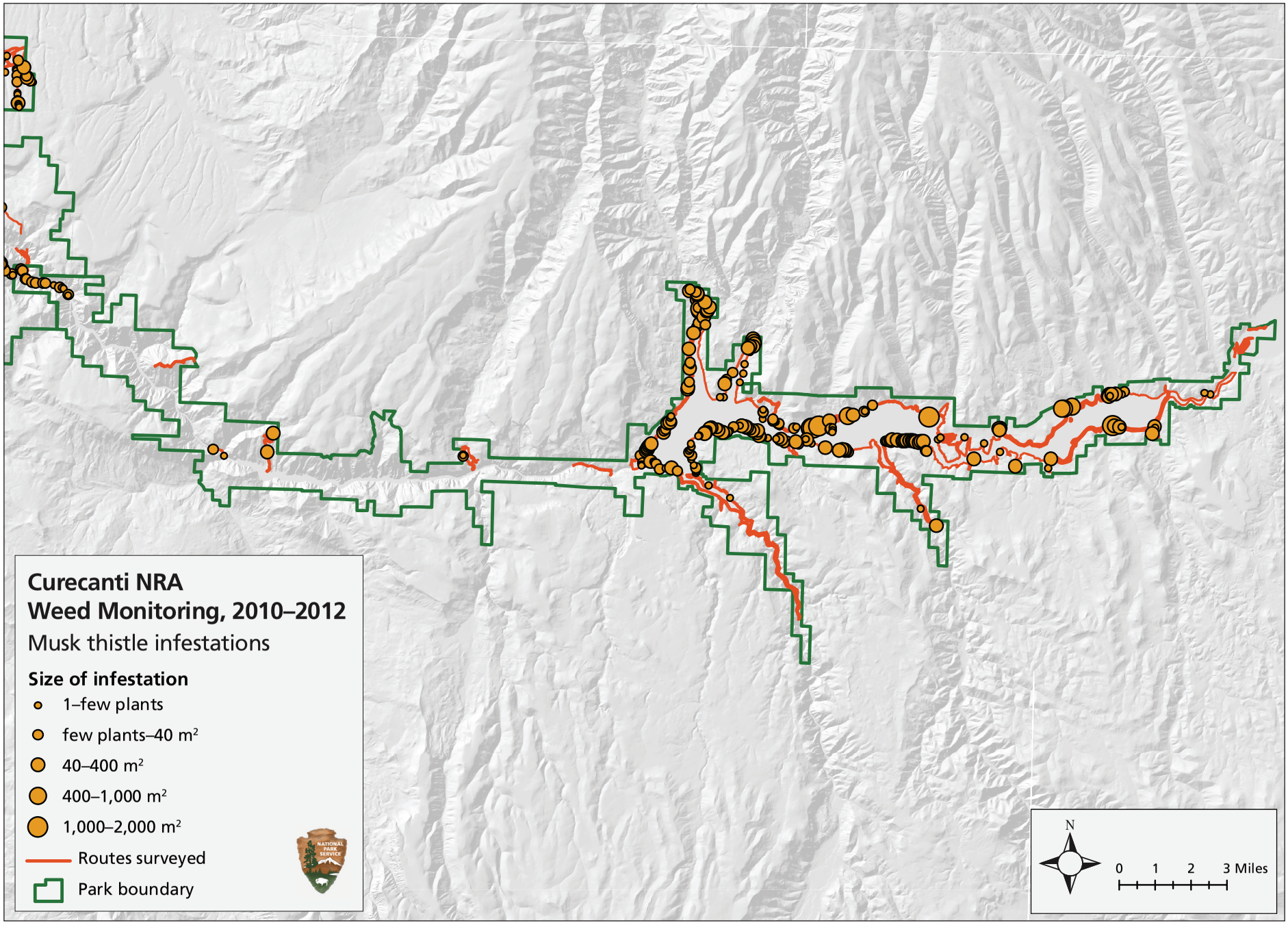


Figure A-10. Musk thistle infestations along monitoring routes, Curecanti National Recreation Area, 2010–2012.

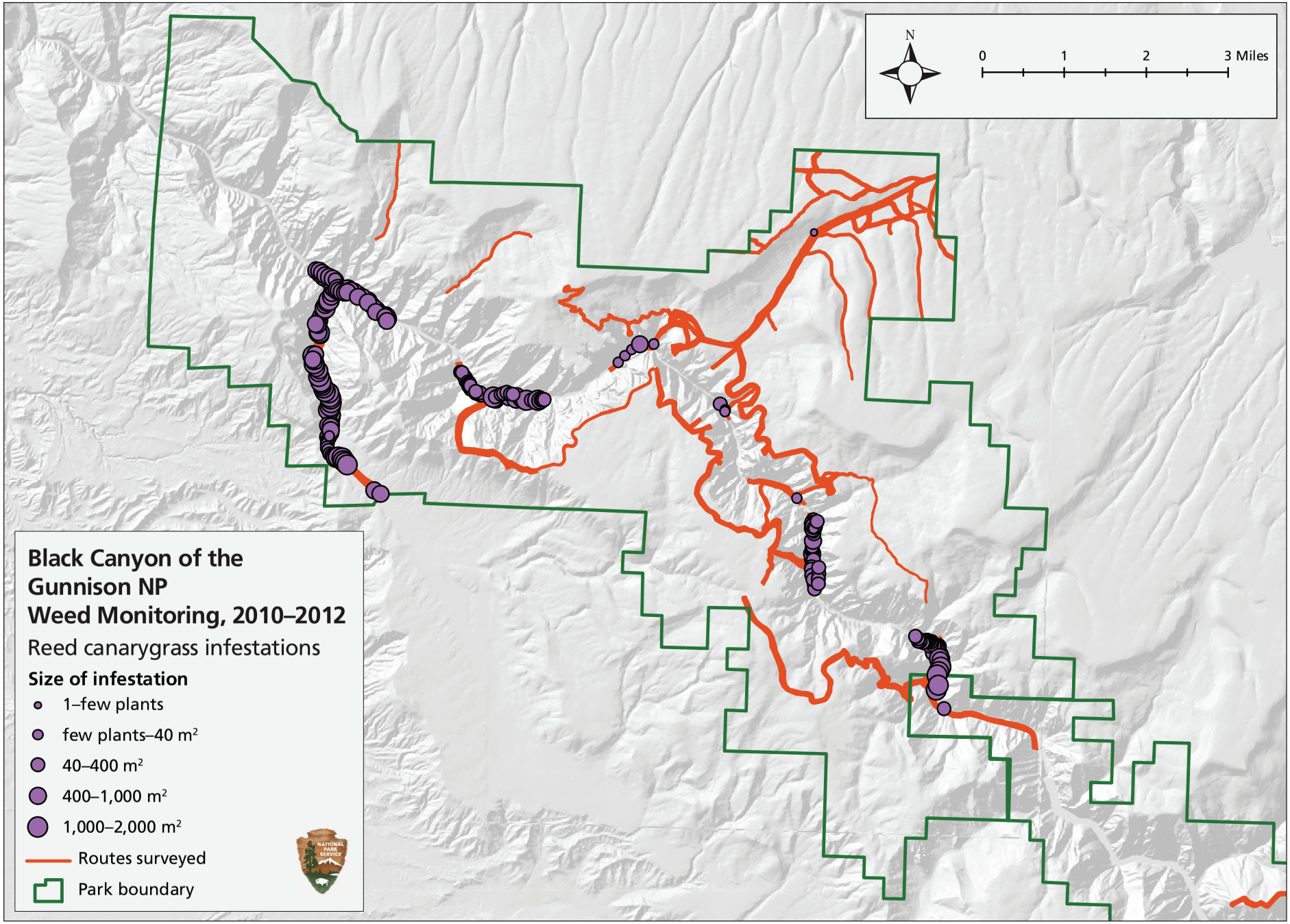


Figure A-11. Reed canarygrass infestations along monitoring routes, Black Canyon of the Gunnison National Park, 2010–2012.

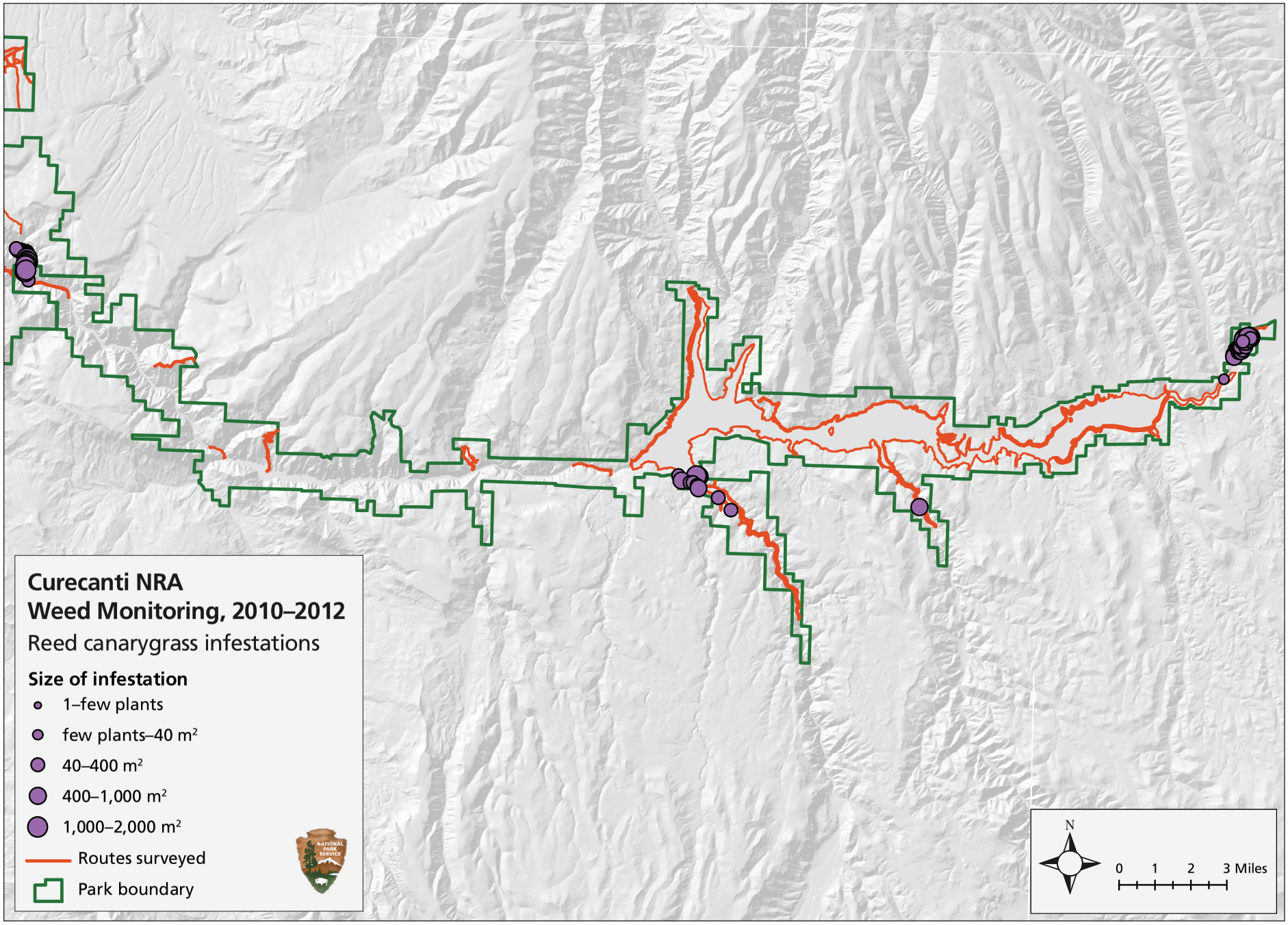


Figure A-12. Reed canarygrass infestations along monitoring routes, Curecanti National Recreation Area, 2010–2012.

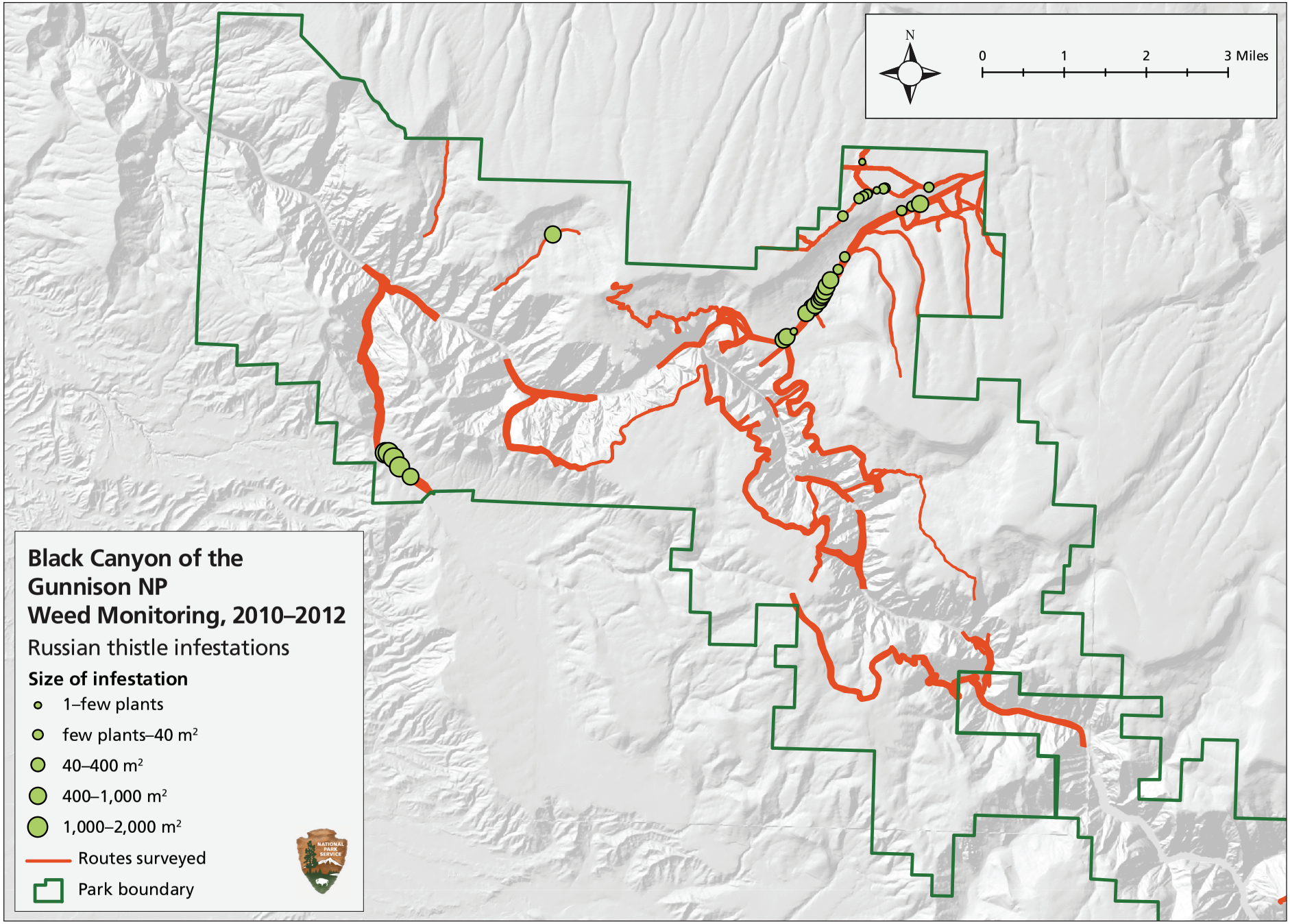


Figure A-13. Russian thistle infestations along monitoring routes, Black Canyon of the Gunnison National Park, 2010–2012.

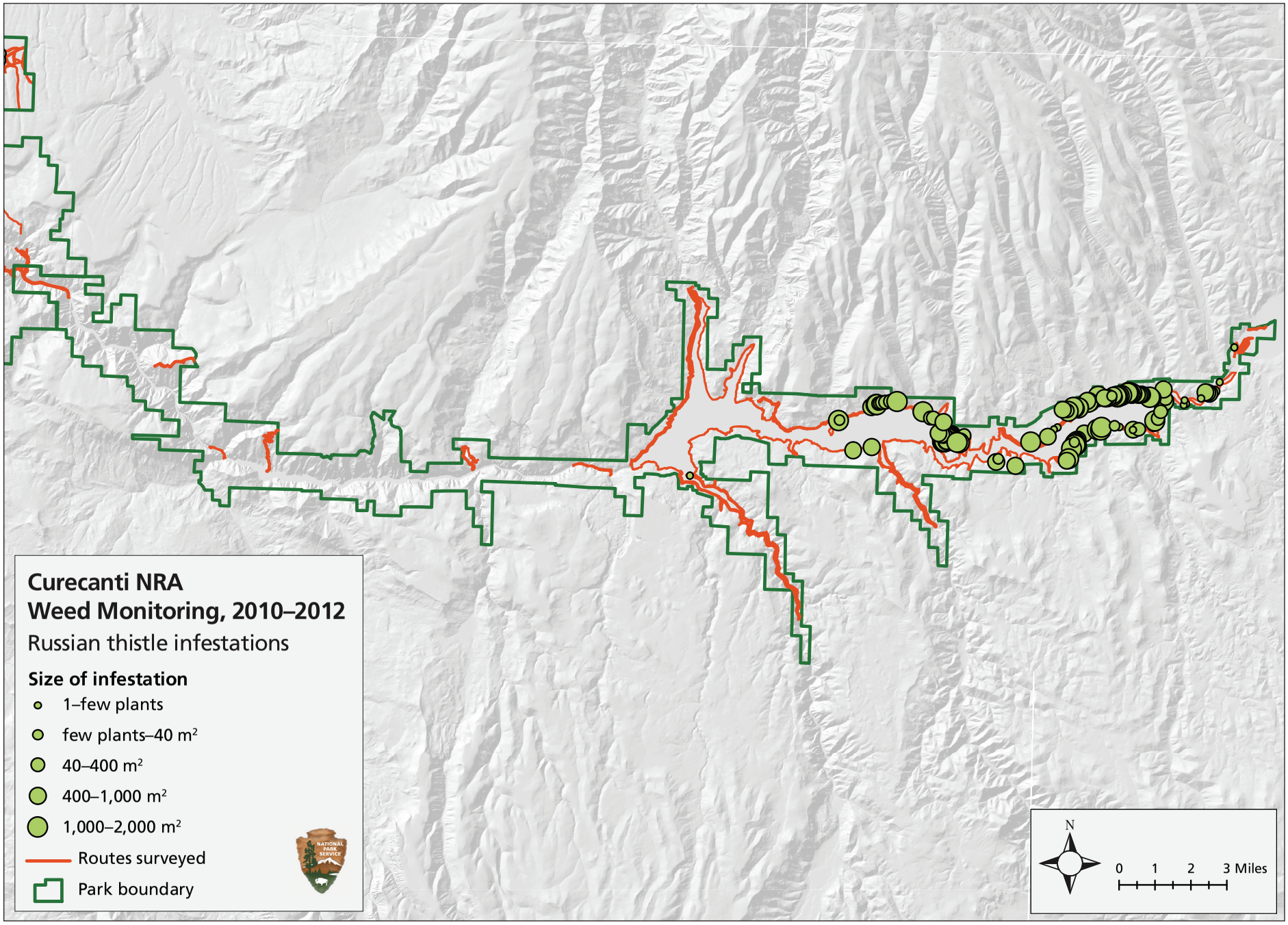


Figure A-14. Russian thistle infestations along monitoring routes, Curecanti National Recreation Area, 2010–2012.

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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