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Invasive Exotic Plant Monitoring at Black Canyon of the Gunnison National Park, 2003–2017

Natural Resource Report NPS/NCPN/NRR—2018/1674



ON THE COVER

Spotted knapweed (*Centaurea maculosa*). NPS/Amy Washuta

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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 11 monitoring protocols to be implemented as part of its long-term monitoring program. This report documents and maps invasive exotic plant infestations detected at Black Canyon of the Gunnison National Park (NP) during 2017. It also summarizes all NPCN work completed in the park in 2003–2015.

In 2017, a total of 115.5 kilometers (71.8 mi) were monitored, covering 65.7 hectares (162.3 acres) at Black Canyon of the Gunnison NP. A total of 1,441 patches of 15 priority IEP species were detected on monitoring routes and transects. Yellow sweetclover (*Melilotus officinale*), musk thistle (*Carduus nutans*), reed canarygrass (*Phalaroides arundinacea*), woolly mullein (*Verbascum thapsus*), Canada thistle (*Breea arvensis*), and spotted knapweed (*Acosta maculosa*) were the most commonly detected priority IEPs. Routes with the highest density of invasive plant patches were the Gunnison River 6–right (51.7/km), Red Rock Canyon (34.2/km), East Portal Road (33/km), and Gunnison River 1 (30/km). Infestation rates were much lower on trails than on riparian and road routes. Most (80.8%) of the IEP patches recorded were 4–400 m^2 in size. Of the six recorded tree patches, four were sapling-stage Siberian elm (*Ulmus pumila*), and two were patches of seedling-stage tamarisk (*Tamarix* sp.).

A total of nine IEP species were detected in 220 transects in 2017. Cheatgrass (*Anisantha tectorum*), reed canarygrass, and yellow sweetclover were the most common IEP species in transects. Cheatgrass was found in similar prevalence across roads and drainages but declined in both presence and percent cover since 2015. Reed canarygrass remained relatively constant in transect cover along the Gunnison River since 2015, but increased in cover in Red Rock Canyon. Yellow sweetclover was most common along roadways, where it remained relatively constant since 2015.

From 2003 to 2017, six IEP species were consistently detected along common monitoring routes in the park. Bull thistle (*Cirsium vulgare*), common burdock (*Arctium minus*), Canada thistle, and woolly mullein patch numbers have generally declined since the 2003–2004 or 2010–2012 surveys. Only two patches of Russian thistle (*Salsola* sp.) were recorded along common routes in 2017, the fewest since surveys began. Russian knapweed (*Acroptilon repens*) has declined across the three common road routes, with only one patch detected in 2017. Since it was added to the IEP list in 2010–2012, the number of patches of reed canarygrass increased considerably between 2010–2012 and 2015 along the Gunnison River 5 route but decreased considerably along the Gunnison River 6 and Red Rock Canyon routes over the same time period. Yellow sweetclover, one of the most widespread IEP species in the park, increased in patch number over most of the routes from 2015 to 2017. Spotted knapweed has increased in the number of patches during each sampling year on the North Rim Roads. Russian knapweed was detected for the first time on the South Rim Road in 2017.

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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 park 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 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:

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

This report summarizes the 2017 field season at Black Canyon of the Gunnison National Park (NP), as well as invasive plant monitoring conducted by Utah State University and the NCPN from 2003 to 2015.

2 Methods

We followed the invasive exotic plant monitoring protocol developed by the NCPN (Perkins et al. 2016). 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 Target invasive exotic plant list

Prior to beginning monitoring in 2017, NCPN and park staff reviewed and updated the park's list of high-priority target IEPs (Table 2-1, next page), initially created in 2010. The original list was developed by reviewing past park literature and state and county weed lists, and consulting with park staff and county weed managers. Our high-priority target IEP list includes 34 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 of 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. The list of priority species is reviewed before each field season, with a few minor changes from year to year.

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 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 are not expected to find every single plant of every targeted IEP species during route surveys. Although searching for single mature plants of some species, such as Russian olive (*Elaeagnus angustifolia*) and tamarisk (*Tamarix* spp.), 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) 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

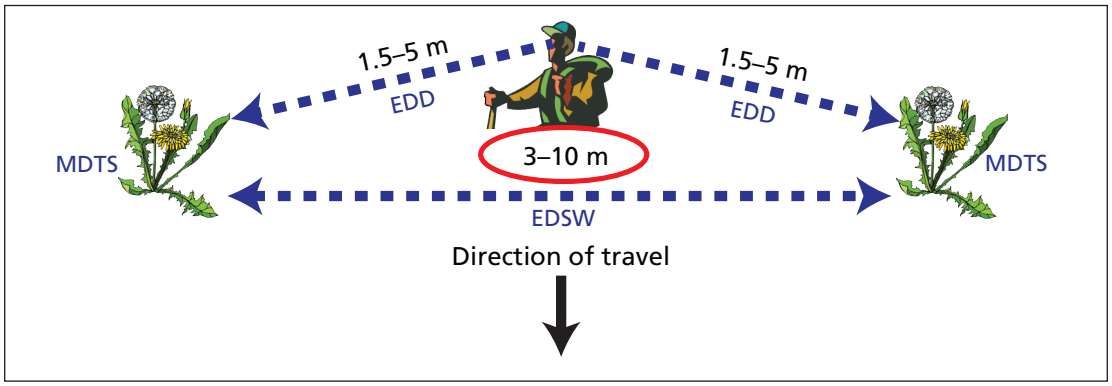


Figure 2-1. The maximum Effective Detection Distance (EDD) at Black Canyon of the Gunnison National Park was 1.5–5 meters, making the Effective Detection Swath Width (EDSW) 3–10 meters.

Table 2-1. Priority invasive exotic plant list, Black Canyon of the Gunnison National Park, 2003–2017.

Scientific name	Common name	2003–2004	2010–2012	2015	2017
Acosta diffusa	diffuse knapweed	X	X	X	X
Acosta maculosa	spotted knapweed	X	X	X	X
Acroptilon repens	Russian knapweed	X	X	X	X
Anisantha tectorum	cheatgrass	X	TO	TO	TO
Arctium minus	common burdock	X	X	X	X
Artemisia absinthium	absinth wormwood	–	X	X	X
Bassia sieversiana	kochia	–	–	X	X
Breea arvensis	Canada thistle	X	X	X	X
Cardaria sp.[1]	hoary cress, whitetop	X	X	X	X
Cardaria latifolia[2]	broad-leaf pepperwort	X	X	X	X
Carduus nutans	musk thistle	X	X	X	X
Cirsium vulgare	bull thistle	X	X	X	X
Convolvulus arvensis	field bindweed	X	X[3]	–	–
Cyclachaena xanthifolia	marsh elder	X	X	X	X
Cynoglossum officinale	houndstongue	X	X	X	X
Elaeagnus angustifolia	Russian olive	X	X	X	X
Tithymalus esula	leafy spurge	X	X	X	X
Hesperis matronalis	Dame's rocket	–	–	X	X
Hyoscyamus niger	black henbane	X	X	X	X
Leucanthemum vulgare	oxeye daisy	–	X	X	X
Linaria genistifolia	Dalmatian toadflax	X	X	X	X
Linaria vulgaris	yellow toadflax	X	X	X	X
Matricaria perforata[4]	scentless chamomile	X	X	X	X
Melilotus officinale	yellow sweetclover	–	–	X	X
Onopordum acanthium	Scotch thistle	X	X	X	X
Phalaroides arundinacea	reed canarygrass	–	X	X	X
Potentilla recta	sulfur cinquefoil	–	–	X	X
Rubus armeniacus	Himalayan blackberry	–	–	X	X
Rumex crispus	curly dock	X	X[3]	–	–
Salsola sp.[5]	Russian thistle	–	X	X	X
Tamarix sp.[6]	tamarisk	X	X	X	X
Ulmus pumila	Siberian elm	X	X	X	X
Verbascum thapsus	woolly mullein	X	X	X	X
Viticella orientalis	oriental clematis	–	X[3]	–	–

TO=transect only

[1]Listed as *Cardaria draba* in 2003–2004 and 2010–2012

[2]*Cardaria latifolia* is listed separately from *Cardaria* sp. because it is easy to differentiate from other *Cardaria* species. Also, *C. latifolia* can have different control strategies than other *Cardaria* species.

[3]2010 only

[4]Listed as *Anthemis* sp. in 2003–2004

[5]Listed as *Salsola australis* in 2010–2015

[6]Listed as *Tamarix ramosissima* in 2003–2004 and 2010–2012

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 Black Canyon of the Gunnison NP in 2017 was 1.5–5 meters.

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 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 was 3–10 meters at Black Canyon of the Gunnison NP in 2017.

2.2.4 Patch separation resolution

We define patch separation resolution (PSR) 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 meters, based on the assumption that most plants or groups of plants separated by less than 50 meters are typically considered to be one patch during planning and implementation of weed control operations. If a patch is continuous for more than 50 meters, then cover estimates are made every 50 meters 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 unit is set to automatically generate these positions every 20 meters.

2.2.6 Data collection methods

The observers walked down the center of the trail/route, searching for IEPs by visually scanning (side-to-side) all the land within the borders of the swath. If the terrain was uneven or steep, and the observers had to glance frequently at the ground to ensure safe foot placement, then searchers stopped approximately every 2.5–10 meters (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 IEPs were consistently recorded during monitoring routes. Survey crew members were given the latitude to record additional IEP species if they were noteworthy. When a priority IEP was discovered, we recorded the following information: (1) monitoring route, (2) patch size class (see below), (3) whether the plant was pulled by the observer, (4) location, and (5) canopy cover class (see below). If several IEPs were present with similar distributions at a single point, then we recorded a point for each individual species. Patch 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 patch: 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).

During data analysis, we developed a patch management index (PMI) to quantify both the extent and the density of a patch into a single value that helps identify the scale of the problem. Park managers will be able to use this tool to help prioritize IEP treatment. PMI was determined using the following formula:

Patch size class (1–5) ×
Patch percent cover (1–5) =
Patch management index (1–25)

We then grouped the PMI into five classes:

1. Very low (1–5)
2. Low (6–10)
3. Moderate (11–-15)
4. High (16–20)
5. Very high (21–25)

Patches identified as very low or low PMI will generally be easier to control or remove than patches with a high or very high PMI. In many cases, directing resources toward controlling patches with very low or low PMI can be a highly effective management strategy; the goal of early detection is to allow managers to eliminate patches before they can grow into bigger problems. Other times, a species with many inventoried patches that are mostly very low or low in PMI may or may not be easier to treat (and possibly eradicate) than a different species that has few inventoried patches that are high or very high in PMI. Therefore, park managers should consider PMI within the context of information on species and patch numbers (see Chapter 4).

2.3 Monitoring transects

2.3.1 Quadrat establishment

We established one transect with three vegetation quadrats every 500 meters along monitoring routes. We centered vegetation quadrats at 0.5, 5, and 10 meters 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-m^2 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, as well as cheatgrass (*Anisantha tectorum*) were recorded in transects. 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 in 2017 and in 2010–2012 and 2015. Estimates of mean percent cover and standard error were generated from the monitoring-transect data for each monitoring route. Due to differences in observers' knowledge, only priority species should be used when comparing results from year to year.

3 Results

3.1 Target invasive exotic plant list

In 2017, field crews searched monitoring routes for 30 species (plus cheatgrass in transects) identified as high priority at Black Canyon of the Gunnison NP (see Table 2-1). Observers were 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 other species are suspect. A total of 16 different IEPs were detected: 15 on monitoring routes and 9 on transects (Table 3-1).

3.2 Monitoring routes

A total of 1,441 patches of 15 IEP species were detected along 115.5 kilometers (71.8 miles) of monitoring routes in 2017 (see Tables 3-2, 3-3, and 3-4, starting on page 9; Figures 3-1 to 3-14; Appendix A at https://irma.nps.gov/DataStore/Reference/Profile/2253868). Routes with the highest density of invasive plant patches were the Gunnison River 6–right (51.7/km), Red Rock Canyon (34.2/km), East Portal Road (33/km), and Gunnison River 1 (30/km). Infestation rates were much lower on trails than on riparian and road routes (Table 3-2).

Yellow sweetclover (*Melilotus officinale*), musk thistle (*Carduus nutans*), reed canarygrass (*Phalaroides arundinacea*), woolly mullein (*Verbascum thapsus*), Canada thistle (*Breea arvensis*), and spotted knapweed (*Acosta maculosa*) were the most commonly detected priority IEPs (Table 3-3). Most (80.8%) of the patches recorded were 4–400 m^2 in size. Only 7.4% of all patches detected were over 400 m^2 in size. The vast majority of patches (95.4%) were very low to low in PMI (Table 3-3). Reed canarygrass comprised most of the medium–very high PMI patches (76.7%).

In 2017, there were six total recorded tree patches, all of which were very low in PMI. Four patches of sapling-stage Siberian elm (*Ulmus pumila*) and two patches of seedling-stage tamarisk (*Tamarix* sp.) were found.

Table 3-1. Invasive exotic plants detected along routes and transects, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

Scientific name	Common name	Method detected	
		Routes	Transects
Acosta maculosa	spotted knapweed	X	X
Acroptilon repens	Russian knapweed	X	–
Arctium minus	common burdock	X	–
Anisantha tectorum	cheatgrass	not surveyed	X
Bassia sieversiana	kochia	X	X
Breea arvensis	Canada thistle	X	X
Carduus nutans	musk thistle	X	X
Cirsium vulgare	bull thistle	X	–
Cynoglossum officinale	houndstongue	X	–
Linaria vulgaris	yellow toadflax	X	–
Melilotus officinale	yellow sweetclover	X	X
Phalaroides arundinacea	reed canarygrass	X	X
Salsola sp.	Russian thistle	X	X
Tamarix sp.	tamarisk	X	–
Ulmus pumila	Siberian elm	X	–
Verbascum thapsus	woolly mullein	X	X

3.3 Monitoring transects

A total of nine IEP species were detected in 220 transects in 2017 (Table 3-4; Appendix B at https://irma.nps.gov/DataStore/Reference/Profile/2253868). IEPs were more prevalent along roads, drainages, and the Gunnison River than on trails. Cheatgrass was found in similar prevalence across roads, drainages, and the Gunnison River. Reed canarygrass was only found in transects along the Gunnison River and Red Rock Canyon, and it had the highest percent cover of any IEP species in these areas. Yellow sweetclover was far more common in transects along roads than in drainages or along the Gunnison River.

3.4 Comparisons among years

3.4.1 Common monitoring routes, 2003–2017

Black Canyon of the Gunnison National Park was previously surveyed for IEPs in 2003–2004 (Dewey and Anderson 2005), 2010–2012 (Perkins 2013), and 2015 (Perkins 2016). The following five routes were commonly sampled in these years and the 2017 survey period: Black Canyon Road, Gunnison River 5, Gunnison River 6, North Rim Road, and South Rim Road. Table 2-1 summarizes the 20 IEP species commonly monitored for across these four survey periods. Unless noted, only data from these common species and routes were used for comparison between years.

Bull thistle (*Cirsium vulgare*), common burdock (*Arctium minus*), Canada thistle, musk thistle, Russian knapweed (*Acroptilon repens*), Russian thistle (*Salsola* sp.), spotted knapweed, and woolly mullein were found during all four sampling periods across the five common routes. Additionally, reed canarygrass has been found in all three survey periods since it was added to the priority IEP list in 2010–2012. Yellow sweetclover was found in both periods since it was added to the priority list in 2015.

Several IEP species have remained relatively constant or declined in prevalence in the park from 2003 to 2017 (Table 3-5). Common burdock, Canada thistle, and woolly mullein have generally declined since the 2003–2004 or 2010–2012 surveys. Musk thistle has declined along the Black Canyon Road, Gunnison River 5, and North Rim Road since 2015—but increased along Red Rock Canyon and the South Rim Road over the same period. The number of patches of bull thistle declined considerably between 2003–2004 and 2010–2012, and remained generally consistent with 2010–2012 numbers during following surveys. Only two patches of Russian thistle were recorded along common routes in 2017, the fewest since surveys began. Russian knapweed has declined across the three common road routes, with only one patch detected in 2017.

Yellow sweetclover was not in the IEP list until 2015, but it is one of the most widespread IEP species in the park. Its patch numbers increased over most of the routes from 2015 to 2017. It is most prevalent along roads, where patch densities of up to 16.87 patches/km were recorded in 2017—the highest of any IEP detected.

Since it was added to the IEP list in 2010–2012, the number of patches of reed canarygrass increased considerably along the Gunnison River 5 route between 2010–2012 and 2015, but decreased considerably along the Gunnison River 6 and Red Rock Canyon routes over the same time period. Since 2015, woolly mullein has declined slightly along the Gunnison River 5 route and increased slightly along the Gunnison River 6 and Red Rock Canyon routes.

3.4.2 Transects, 2010–2017

Transects have been conducted along routes in Black Canyon of the Gunnison National Park since the 2010–2012 survey. Across routes consistently monitored from 2010 to 2017, the presence of reed canarygrass within transects along the Gunnison River and Red Rock Canyon increased to their highest levels in 2017. Cheatgrass declined considerably in presence within transects between 2015 and 2017 (Table 3-6). The presence of yellow sweetclover within transects increased slightly between 2015 and 2017 along the Gunnison River routes, Red Rock Canyon, North Rim drainages, and North Rim roads.

Table 3-2. Number of priority IEP patches per route, and number per kilometer by route type, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

Route	Route type	Length (km)	Area (ha)	Total patches	Patches/km
Drainage 1	Riparian	1.74	0.87	35	20.1
Drainage 9	Riparian	2.57	1.80	6	2.3
Drainage 12	Riparian	2.02	1.01	18	8.9
Drainage 14	Riparian	3.03	1.51	8	2.6
Drainage 15	Riparian	2.07	0.83	15	7.2
Grizzly Gulch	Riparian	7.55	6.36	84	11.1
Gunnison River 1	Riparian	1.46	0.88	44	30.0
Gunnison River 2	Riparian	1.58	1.59	19	12.0
Gunnison River 5	Riparian	1.48	1.49	16	10.8
Gunnison River 6–left	Riparian	1.04	0.83	13	12.5
Gunnison River 6–right	Riparian	1.14	0.92	59	51.7
Red Rock Canyon	Riparian	5.00	5.00	171	34.2
	Total riparian	***30.68***	***23.09***	***488***	***17.0 avg.***
4WD Road 1	Road	1.19	0.60	0	0
4WD Road 5	Road	0.38	0.19	0	0
4WD Road 10	Road	0.44	0.26	5	11.5
Black Canyon Road	Road	5.42	5.41	104	19.2
Closed road	Road	3.00	1.74	43	14.4
Corral Service Road	Road	0.59	0.29	13	22.1
East Portal Road	Road	6.82	2.73	225	33.0
North Rim Road	Road	14.83	6.25	246	16.6
Service Road 1	Road	4.52	1.36	103	22.8
Service Road 2	Road	1.53	0.76	29	18.9
South Rim Road	Road	27.19	14.05	146	5.4
	Total roads	***65.91***	***33.64***	***914***	***14.9 avg.***
Campground to Gunnison River	Trail	1.33	0.66	0	0
Chasm View	Trail	0.75	0.30	0	0
Cross Fissures	Trail	0.31	0.15	0	0
Deadhorse Trail	Trail	4.22	2.95	19	4.5
Dragon Point	Trail	0.26	0.13	0	0
Island Peaks Trail	Trail	0.37	0.14	1	2.7
North Vista	Trail	5.72	1.71	0	0
Rock Point	Trail	0.29	0.14	1	3.5
The Narrows	Trail	0.31	0.21	0	0
Warner Point Nature Trail	Trail	1.23	0.61	0	0
Warner Route	Trail	2.00	1.00	0	0
	Total trails	***16.79***	***8.00***	***21***	***1.0 avg.***
Grand totals		**113.00**	**65.00**	**1,423**	**11 avg.**

This chart does not include 18 patches that were recorded off of routes.

Table 3-3. Number of patches by species, patch size class, and patch management index detected along all monitoring routes, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

Scientific name	Common name	Total patches	Patch size class[1]					Patch management index[2]				
			1	2	3	4	5	Very low	Low	Medium	High	Very high
Acosta maculosa	spotted knapweed	73	13	44	16	0	0	34	37	2	0	0
Acroptilon repens	Russian knapweed	13	1	11	0	1	0	9	4	0	0	0
Arctium minus	common burdock	12	7	3	2	0	0	12	0	0	0	0
Bassia sieversiana	kochia	21	0	2	5	7	7	8	8	3	2	0
Breea arvensis	Canada thistle	87	17	44	24	2	0	62	23	0	0	0
Carduus nutans	musk thistle	242	63	102	55	16	6	211	24	4	0	0
Cirsium vulgare	bull thistle	9	4	4	1	0	0	9	0	0	0	0
Cynoglossum officinale	houndstongue	2	0	2	0	0	0	1	1	0	0	0
Linaria vulgaris	yellow toadflax	2	0	1	1	0	0	0	2	0	0	0
Melilotus officinale	yellow sweetclover	708	22	370	299	15	2	347	357	1	1	0
Phalaroides arundinacea	reed canarygrass	140	0	36	57	42	5	28	66	24	21	1
Salsola sp.	Russian thistle	16	4	6	3	2	1	10	5	1	0	0
Tamarix sp.	tamarisk	2	2	0	0	0	0	2	0	0	0	0
Ulmus pumila	Siberian elm	4	4	0	0	0	0	4	0	0	0	0
Verbascum thapsus	woolly mullein	110	33	45	32	0	0	104	6	0	0	0
Grand totals		**1,441**	**170**	**670**	**495**	**85**	**21**	**841**	**533**	**35**	**24**	**1**

[1]Patch 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).

[2]PMI classes: Very low (1–5), Low (6–10), Medium (11–15), High (16–20), Very high (21–25). PMI = Patch size class (1–5) × Patch percent cover (1–5).

Table 3-4. Number of monitoring transects where exotic plant species were detected (of total number of transects monitored), mean percent cover, and standard error by area, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

		Gunnison River		Red Rock Canyon		North Rim Drainages		North Rim Roads		South Rim Roads		Trails	
Scientific name	Common name	Detected (of 12)	Percent cover (SE)	Detected (of 10)	Percent cover (SE)	Detected (of 37)	Percent cover (SE)	Detected (of 59)	Percent cover (SE)	Detected (of 69)	Percent cover (SE)	Detected (of 33)	Percent cover (SE)
Acosta maculosa	spotted knapweed	0	0.00	0	0	1	0.04 (0.04)	2	0.02 (0.02)	0	0	0	0
Anisantha tectorum	cheatgrass	1	0.01 (0.01)	1	0.05 (0.05)	3	0.03 (0.02)	1	0.00 (0.00)	0	0	1	0.01 (0.01)
Bassia sieversiana	kochia	0	0.00	3	0.03 (0.20)	0	0	0	0	0	0	0	0
Breea arvensis	Canada thistle	1	0.03 (0.03)	0	0	1	0.00 (0.00)	0	0	1	0.00 (0.00)	0	0
Carduus nutans	musk thistle	0	0.00	0	0	2	0.02 (0.01)	5	0.02 (0.01)	2	0.00 (0.00)	0	0
Melilotus officinale	yellow sweetclover	1	0.06 (0.06)	1	0.02 (0.02)	3	0.21 (0.15)	28	1.05 (0.46)	12	0.24 (0.08)	0	0
Phalaroides arundinacea	reed canarygrass	10	6.54 (3.24)	4	16.73 (6.98)	0	0	0	0	0	0	0	0
Salsola sp.	Russian thistle	0	0.00	2	0.03 (0.02)	0	0	0	0	0	0	0	0
Verbascum thapsus	woolly mullein	1	0.11 (0.11)	0	0	1	0.03 (0.03)	0	0	0	0	0	0

Gunnison River = Gunnison River routes 1, 2, 5, 6
North Rim Drainages = Drainage 1, Drainage 12, Drainage 14, Drainage 15, Drainage 9, Grizzly Gulch
North Rim Roads = 4WD Road 1, 4WD Road 10, Black Canyon Road, Closed Road, Corral Service Road, North Rim Road, Service Road 1, Service Road 2
South Rim Roads = East Portal Road, South Rim Road
Trails = Campground to Gunnison River, Chasm View Trail, Deadhorse Trail, Gunnison Route, Island Peaks Trail, North Vista Trail, Rim Rock Trail, Warner Point Nature Trail, Warner Route

Table 3-5. Patches of priority IEP species (minimum of 10 total detections across four survey periods) observed on routes commonly monitored from 2003 to 2017, Black Canyon of the Gunnison National Park.

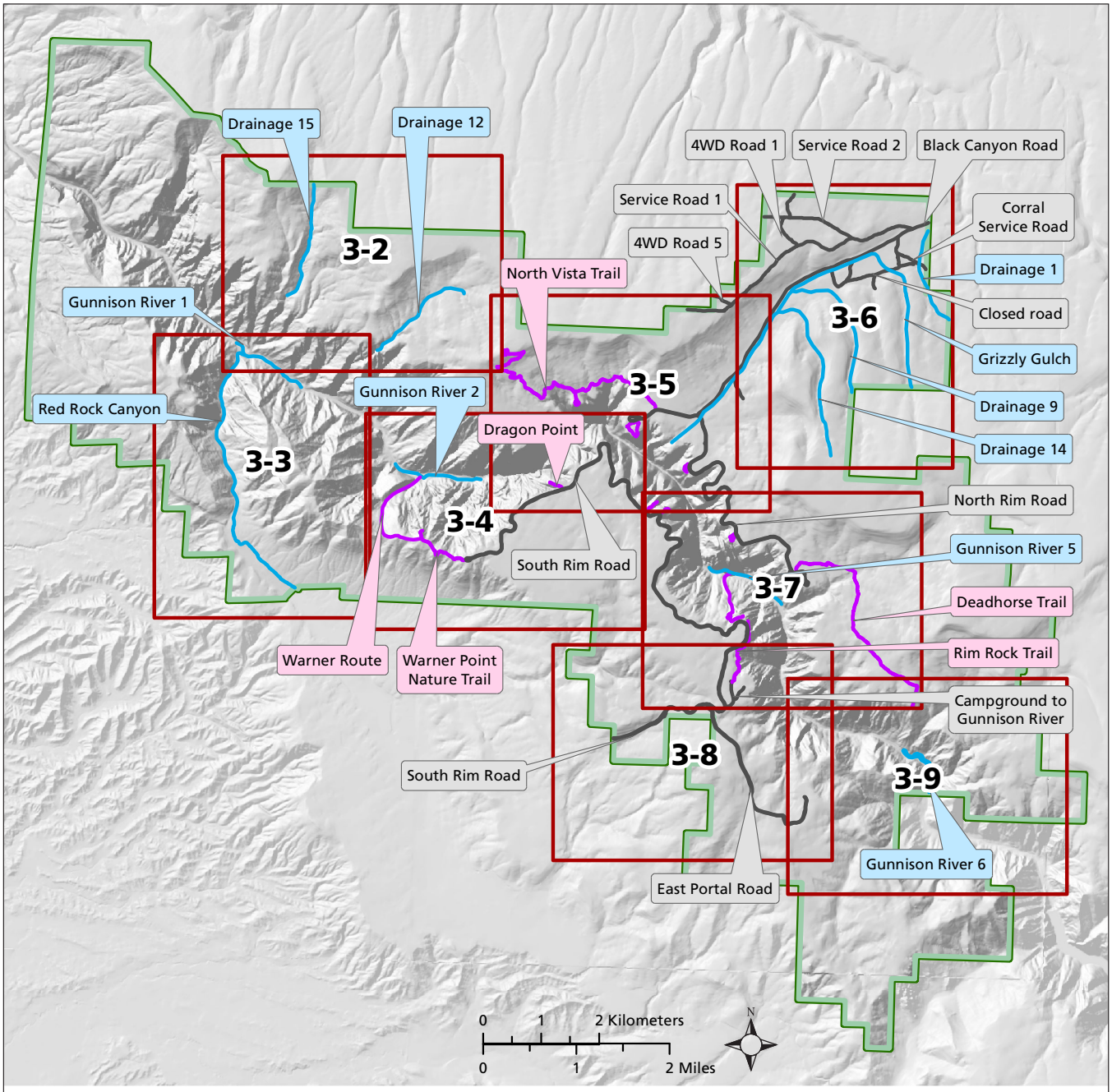
Route	Scientific name	Common name	2003–2004	2010–2012	2015	2017
Black Canyon Rd	*Breea arvensis*	Canada thistle	5	4	2	0
	Carduus nutans	musk thistle	19	17	43	24
	Salsola sp.	Russian thistle	8	18	6	0
	Melilotus officinale	yellow sweetclover	NR	NR	86	70
Gunnison River 6	*Breea arvensis*	Canada thistle	22	39	14	12
	Cirsium vulgare	bull thistle	14	4	6	6
	Melilotus officinale	yellow sweetclover	NR	NR	7	3
	Phalaroides arundinacea	reed canarygrass	NR	47	22	25
	Verbascum thapsus	woolly mullein	21	23	9	12
Gunnison River 5	*Arctium minus*	common burdock	2	6	1	1
	Breea arvensis	Canada thistle	5	11	0	1
	Carduus nutans	musk thistle	8	2	1	0
	Phalaroides arundinacea	reed canarygrass	NR	1	18	13
	Verbascum thapsus	woolly mullein	23	24	2	1
North Rim Road	*Carduus nutans*	musk thistle	10	14	14	7
	Salsola sp.	Russian thistle	7	0	3	1
	Melilotus officinale	yellow sweetclover	NR	NR	80	231
Red Rock Canyon	*Arctium minus*	common burdock	52	42	11	11
	Breea arvensis	Canada thistle	48	11	12	12
	Carduus nutans	musk thistle	47	33	9	12
	Melilotus officinale	yellow sweetclover	NR	NR	8	2
	Phalaroides arundinacea	reed canarygrass	NR	53	38	40
	Verbascum thapsus	woolly mullein	24	11	14	3
South Rim Road	*Breea arvensis*	Canada thistle	9	4	10	5
	Carduus nutans	musk thistle	2	5	8	14
	Verbascum thapsus	woolly mullein	8	7	10	5
	Melilotus officinale	yellow sweetclover	NR	NR	52	42

NR = not recorded (plant was not on the priority list during that sampling period)

Table 3-6. Percent of transects where selected IEP species were observed on routes commonly monitored between 2010 and 2012, 2015, and 2017.

Route	Year(s) and # of transects	*Anisantha tectorum*	*Melilotus officinale*	*Phalaroides arundinacea*
Gunnison River	2010–2012 (n=9)	0.00%	NR	55.56%
	2015 (n=12)	25.00%	8.33%	50.00%
	2017 (n=10)	10.00%	10.00%	60.00%
Red Rock Canyon	2010–2012 (n=9)	0.00%	NR	22.22%
	2015 (n=18)	50.00%	5.56%	16.67%
	2017 (n=11)	9.09%	9.09%	36.36%
North Rim Drainages	2010–2012 (n=40)	0.00%	NR	0.00%
	2015 (n=38)	26.32%	2.63%	0.00%
	2017 (n=40)	7.50%	7.50%	0.00%
North Rim Roads	2010–2012 (n=35)	0.00%	NR	0.00%
	2015 (n=60)	35.00%	40.00%	0.00%
	2017 (n=64)	1.56%	43.75%	0.00%
South Rim Road	2010–2012 (n=18)	5.56%	NR	0.00%
	2015 (n=16)	37.50%	0.00%	0.00%
	2017 (n=15)	0.00%	0.00%	0.00%
Trails	2010–2012 (n=15)	0.00%	NR	0.00%
	2015 (n=22)	9.09%	0.00%	0.00%
	2017 (n=20)	5.00%	0.00%	0.00%

NR = not recorded (plant was not on the priority list during that sampling period)
Gunnison River = Gunnison River routes 1, 5, 6
North Rim Drainages = Drainage 1, Drainage 12, Drainage 14, Drainage 15, Drainage 9, Grizzly Gulch
North Rim Roads = 4WD Road 1, 4WD Road 10, Black Canyon Road, Closed Road, Corral Service Road, North Rim Road, Service Road 1, Service Road 2
South Rim Roads = South Rim Road
Trails = Deadhorse Trail, Gunnison Route, North Vista Trail



Black Canyon of the Gunnison NP Weed Monitoring Areas, 2017

Monitoring route types

- Drainage
- Road
- Trail
- Subsequent map figures
- Park boundary

Monitoring Areas

3-2: Green Mountain
3-3: Red Rock Canyon
3-4: Warner Point Nature Trail
3-5: North Vista Trail
3-6: Black Canyon Road
3-7: North and South Rim Roads
3-8: South Rim Road and East Portal Road
3-9: Gunnison River at East Portal

Monitoring routes: 71.8 miles/115.5 kilometers; Area surveyed: 162.3 acres/65.7 hectares; IEP patches mapped: 1,441

Figure 3-1. Index map of invasive plant monitoring routes, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

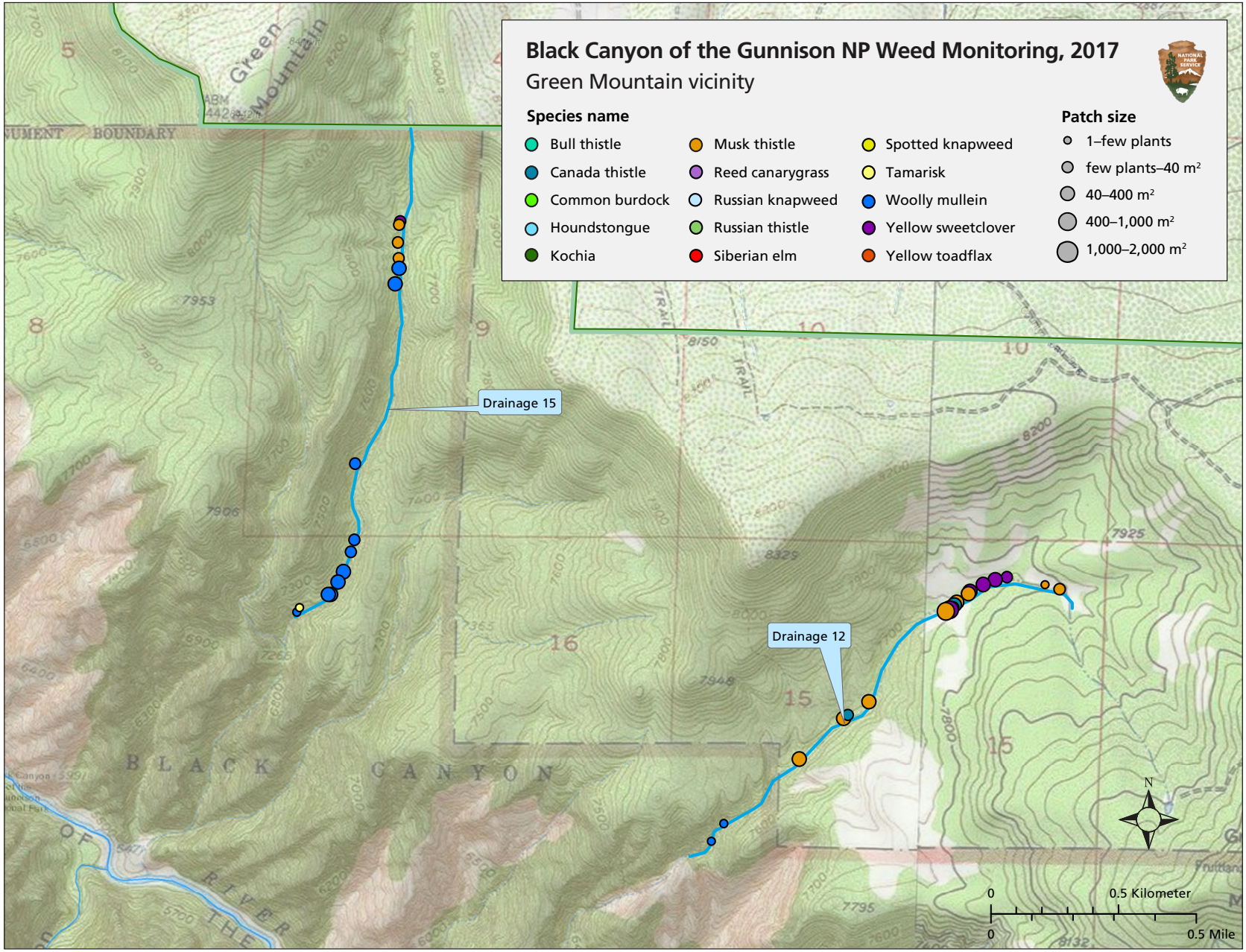


Figure 3-2. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of Green Mountain, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

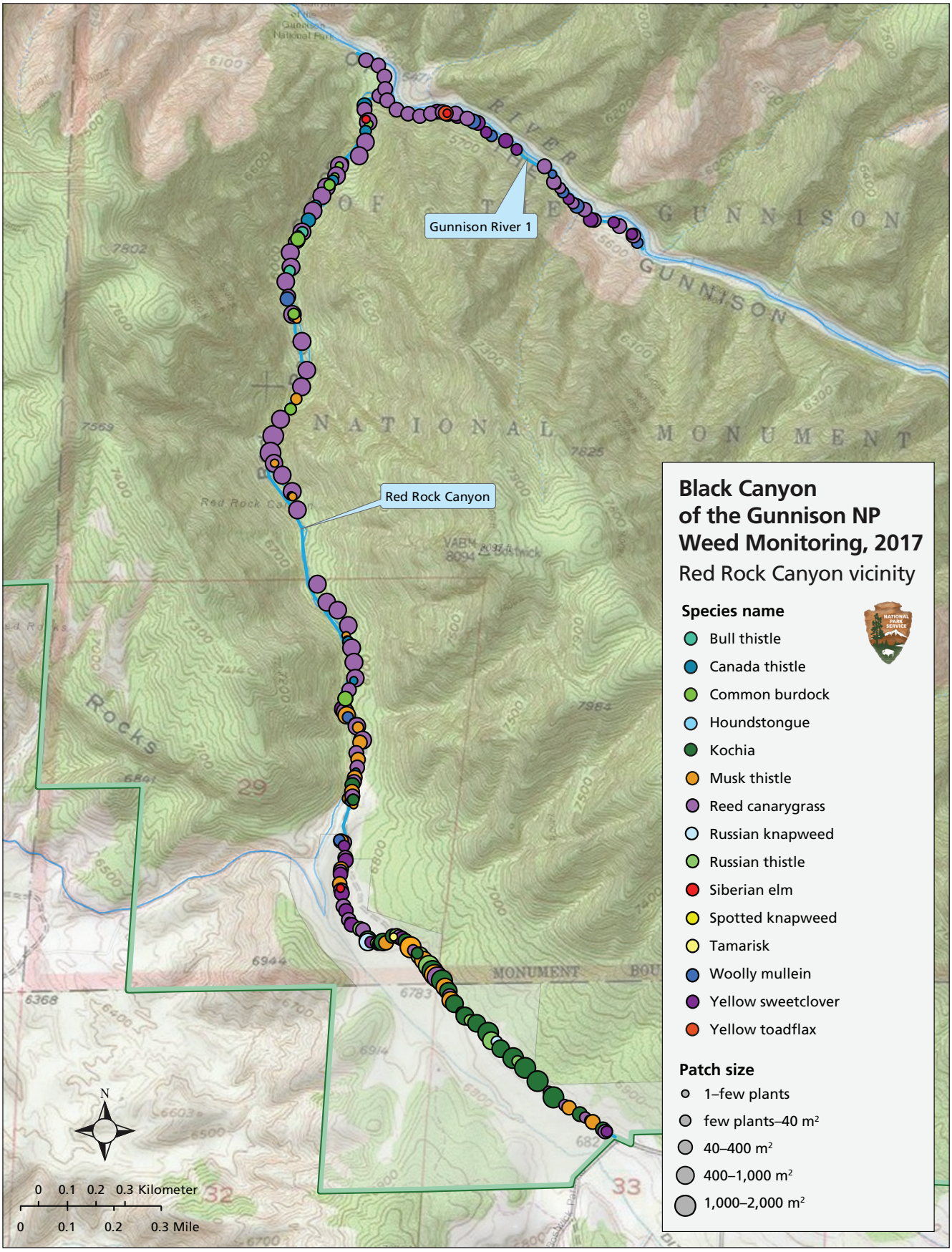


Figure 3-3. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of Red Rock Canyon, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

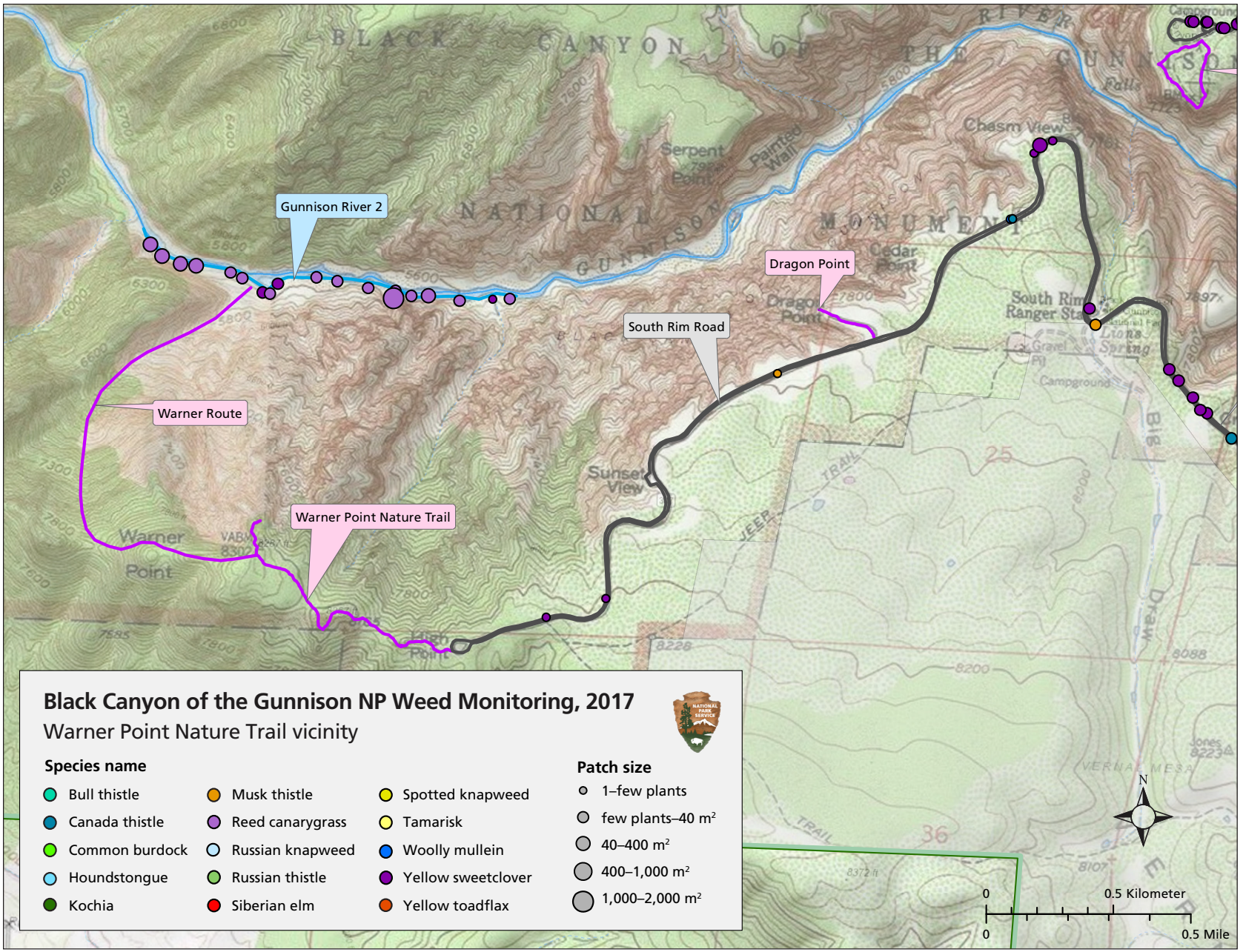


Figure 3-4. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of Warner Point Nature Trail, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

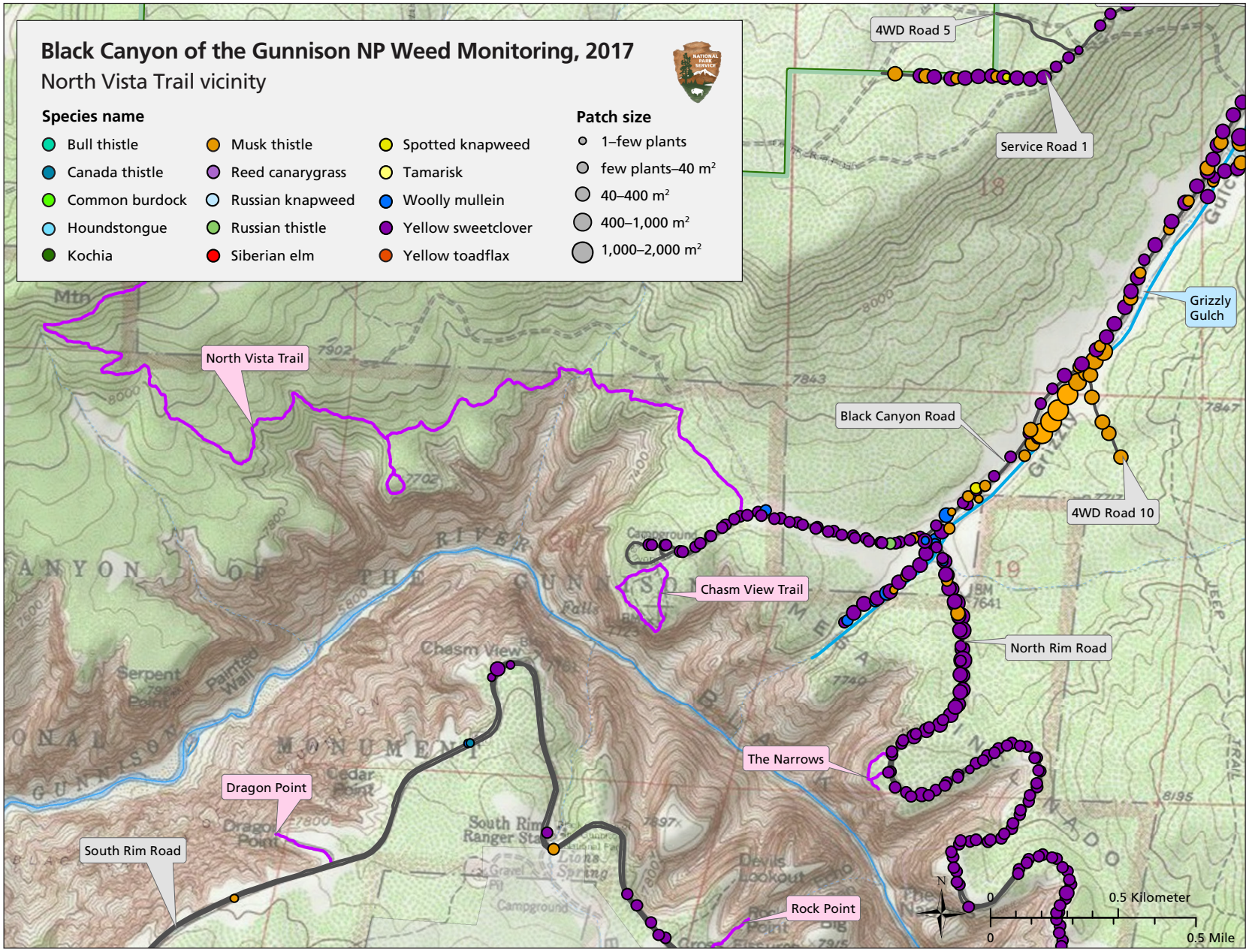


Figure 3-5. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of North Vista Trail, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

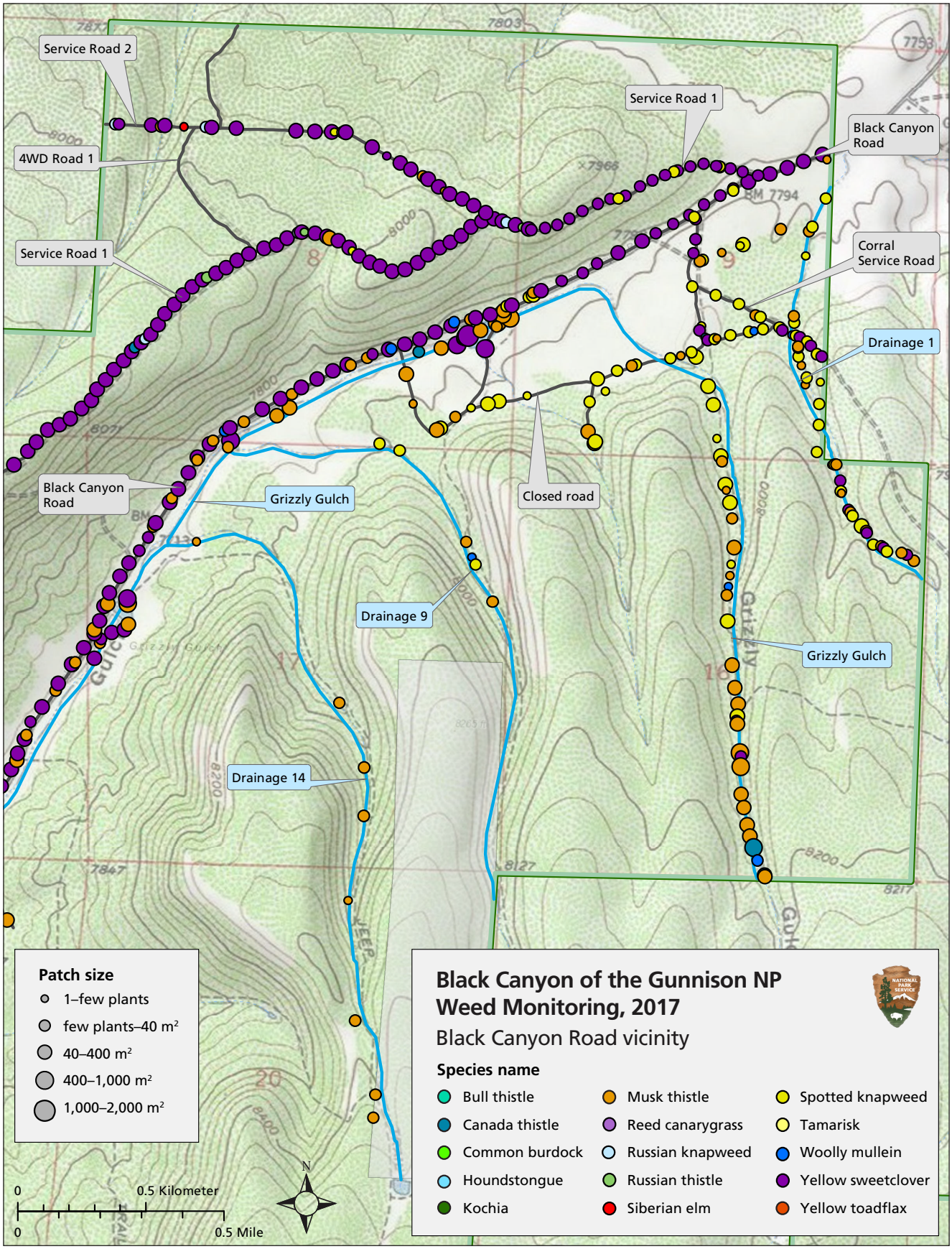


Figure 3-6. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of the Black Canyon Road, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

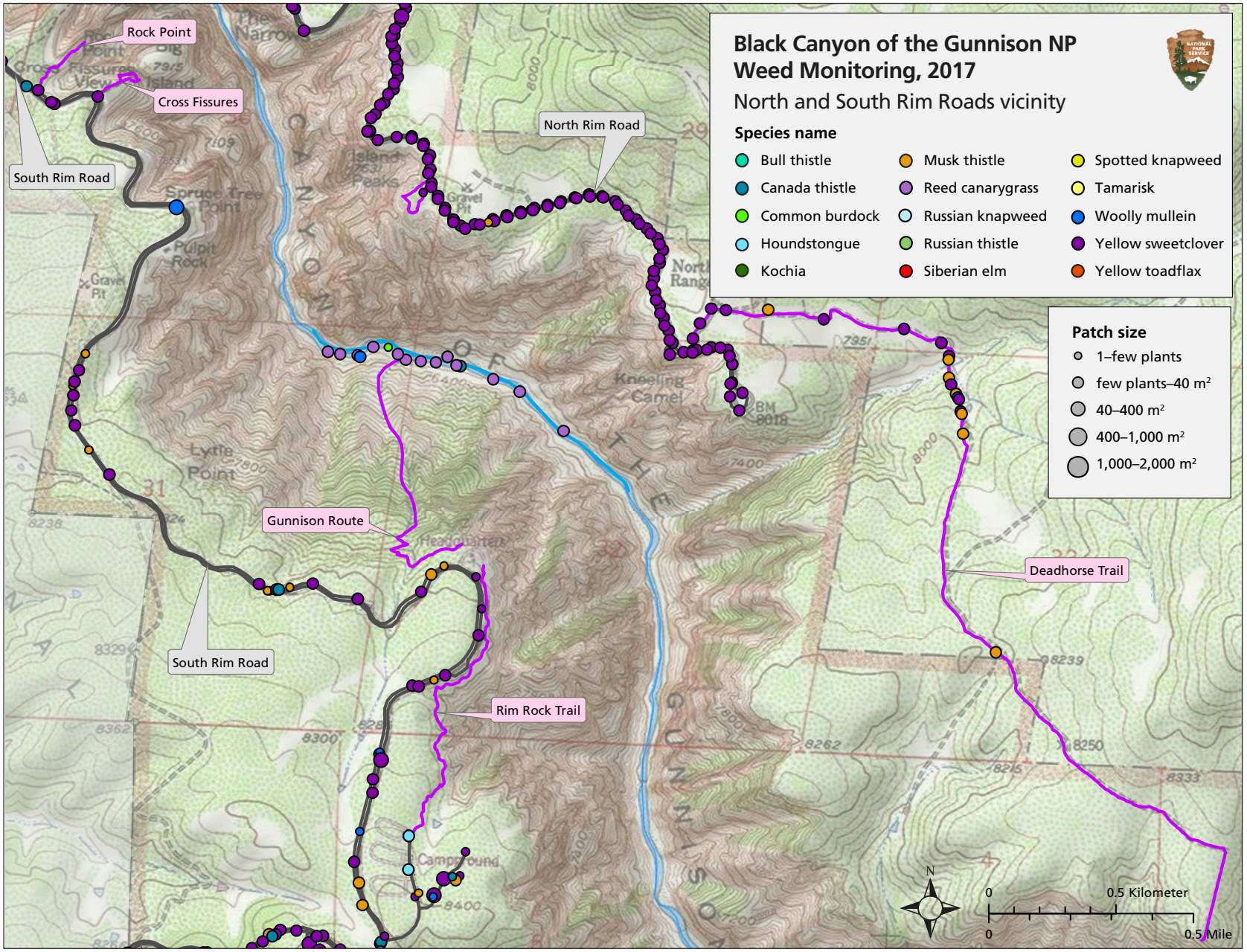


Figure 3-7. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of the North and South Rim roads, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

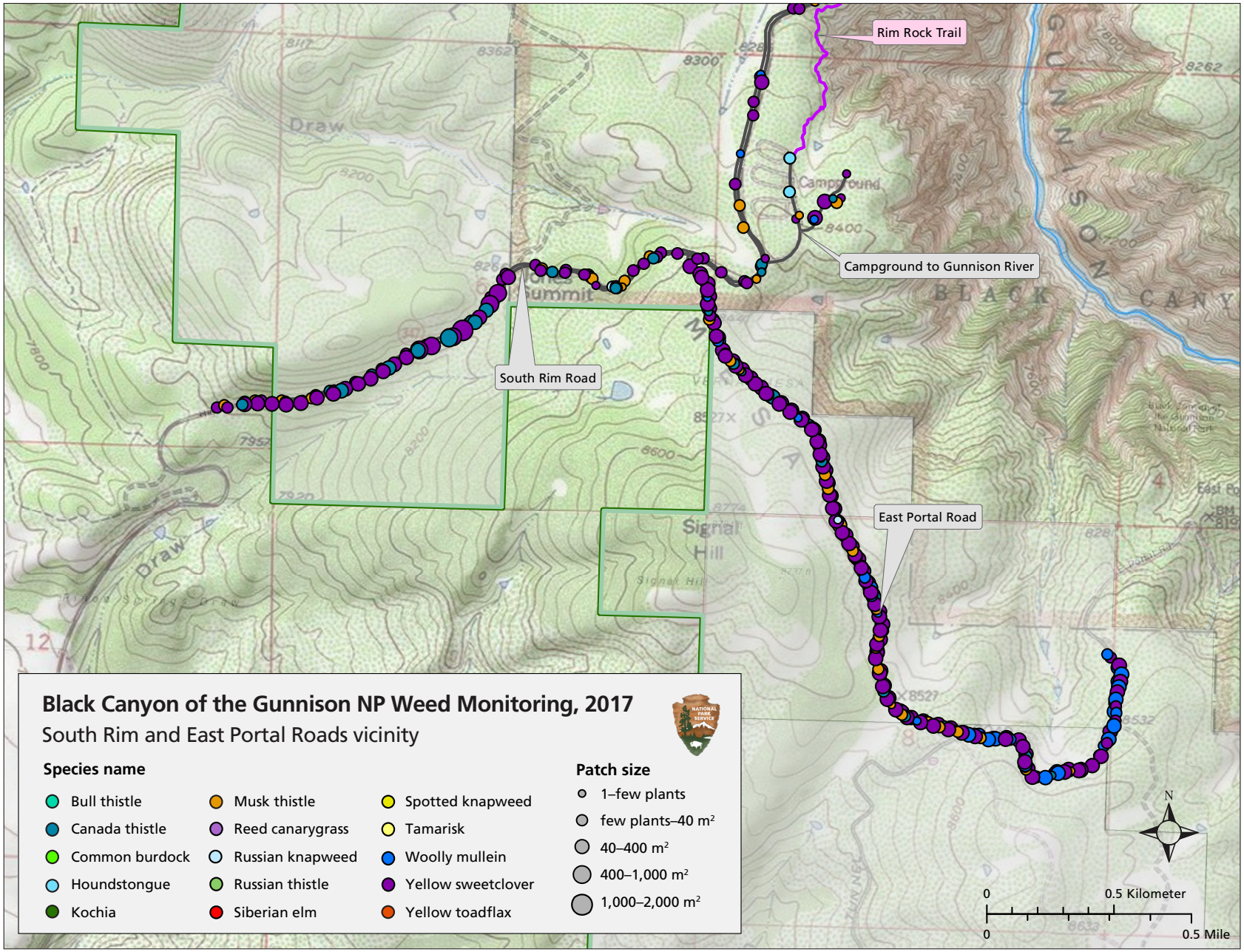


Figure 3-8. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of the South Rim Road and East Portal Road, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

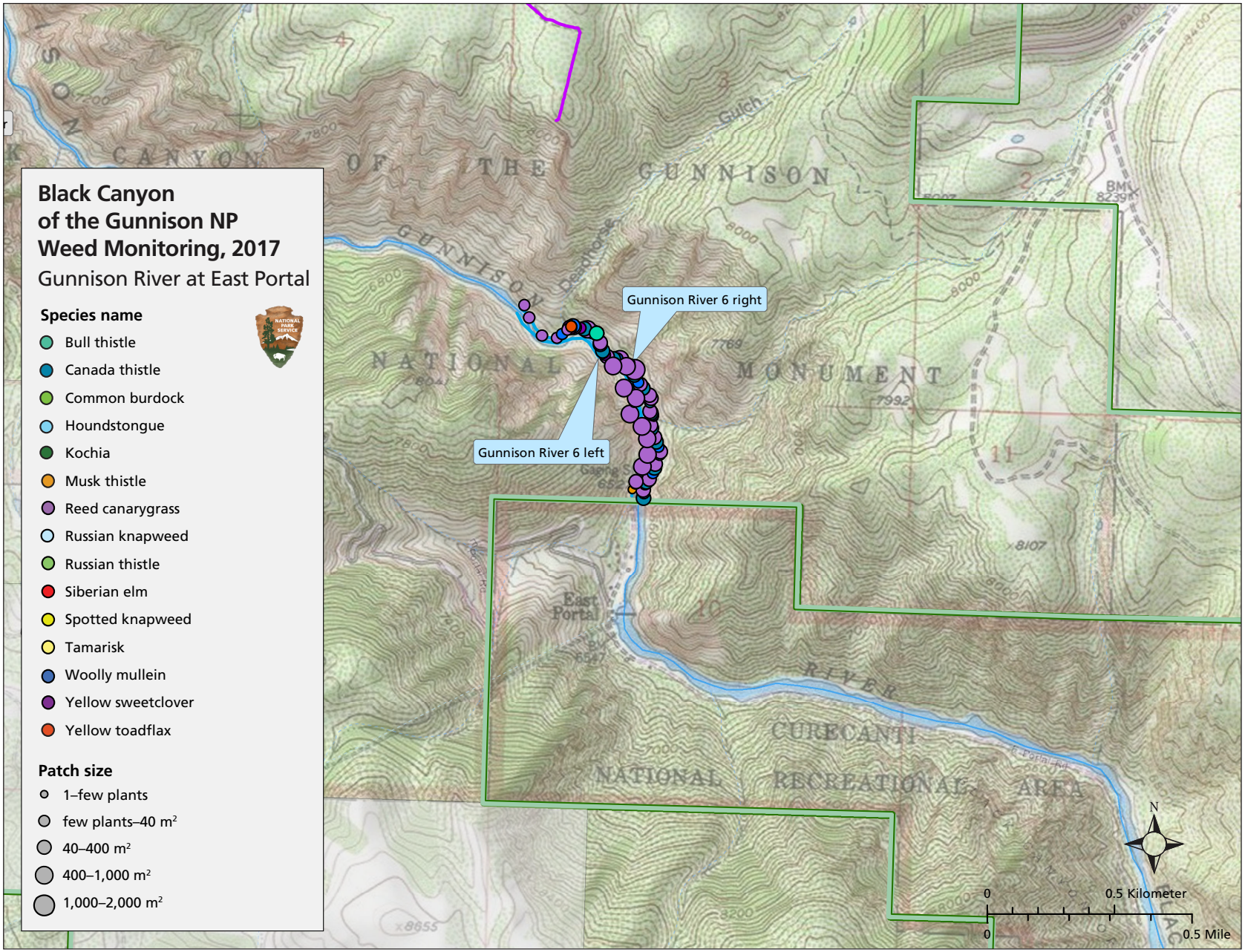


Figure 3-9. Invasive plants detected on monitoring routes and monitoring quadrats in the vicinity of the Gunnison River at East Portal, Black Canyon of the Gunnison National Park, July 26–August 2, 2017.

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. 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 species in all years.

4.2 Possibilities for management control

In 2017, priority IEP species were generally most widespread along drainages, the Gunnison River, and roads. They were relatively rare on hiking trails. The East Portal Road, the Gunnison River, and Red Rock Canyon had the highest rates of infestation, followed by the North Rim roads and nearby drainages. Yellow sweetclover, musk thistle, reed canarygrass, woolly mullein, Canada thistle, and spotted knapweed were the most commonly detected priority IEPs (see Table 3-3). With adequate resources, all of these—except for reed canarygrass—have good potential to be controlled.

While the PMI was originally intended to elucidate trends in IEP populations over time, it can also be used to inform treatment decisions. A very low or low classification indicates a patch that is either small in area, sparse in cover, or both small in area and sparse in cover. *However, patches with very low or low PMI should not be interpreted as insignificant*. On the contrary, these patches may be some of the most important areas to treat, especially for isolated and/or uncommon species. Prioritizing treatment of small-scale patches can effectively prevent future spread and possible eradication.

For more widespread species, such as yellow sweetclover, the large number of patches with very low and low PMI indicates that this species is sparsely scattered across a broad landscape. Therefore, while controlling an individual patch might require minimal effort, controlling the population will require traversing large areas. Similarly, while patches with higher PMI will be more difficult to manage and treat due to their larger size and denser cover, they also represent opportunities for possible eradication if patch numbers for a given species are low. Reed canarygrass patches tended to be higher in PMI than other IEP species, which speaks to the dense, concentrated growth of this species along perennial watercourses. Ultimately, managers should consider species traits (e.g., how likely and quickly plants may spread) and environmental conditions (precipitation and temperature), and combine this information with patch number and PMI values when determining treatment priorities.

There are several uncommonly detected species that should continue to be monitored and their populations eradicated when found. Houndstongue (*Cynoglossum officinale*) was detected for the first time in these surveys in 2017 in the area surrounding the South Rim campground. Dame's rocket (*Hesperis matronalis*), whitetop (*Cardaria* sp.), marsh elder (*Cyclachaena xanthifolia*), scentless chamomile (*Matricaria perforata*), Scotch thistle (*Onopordum acanthium*), and oxeye daisy (*Leucanthemum vulgare*) were found in at least one previous year, but not in 2017. Tamarisk and Siberian elm were uncommon along routes, with all patches relatively small and isolated. Eradication and continued monitoring is important for these species.

Park trails had very low numbers of IEP patches when compared to roads and drainages (see Table 3-2). This suggests that there are still large areas of the park where there are few patches. 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.

4.3 Summary of trends across study years

There has been an increase in the number of patches of several IEP species on both the North and South Rim roads. At the same time, the number of patches of some IEP species has decreased along the Gunnison River. However, the park has not focused control work there. Environmental peak flows may be having an effect on some of these species. This decline may be attributable to dam releases in May 2017 that sent the highest recorded flows downstream since 1958. Several IEP species have declined in Red Rock Canyon and East Portal Road, likely due to the park's control efforts in these areas.

4.4 Future monitoring efforts

IEPs at Black Canyon of the Gunnison NP will generally be monitored at the same time of year in the future. 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 MDTS.

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.

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